Boise Project, Deer Flat Embankments
Lake Lowell
Nampa Vicinity
Canyon County
Idaho

HAER No, ID-17-B

HAER
ID
14-NAMPA.V
1B-

PHOTOGRAPHS

WRITTEN HISTORICAL AND DESCRIPTIVE DATA

Historic American Buildings Survey
National Park Service
Western Regional Office
Department of the Interior
San Francisco, California 94102

HISTORIC AMERICAN ENGINEERING RECORD

BOISE PROJECT, DEER FLAT EMBANKMENTS

HAER No. ID-17-B

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14-NAMPA.V,
1B-

Location:	Lake Lowell, four miles southwest of Nampa, Canyon County, Idaho
Quads:	Lake Lowell and Nampa
UTM:	Zone 11 Lower Embankment, South End: E - 520410; N - 4824430 Lower Embankment, North End: E - 522010; N - 4826040 Upper Embankment, West End: E - 527580; N - 4822950 Upper Embankment, East End: E - 528410; N - 4822750 Middle (Forest) Embankment: E - 522820; N - 4826810 East Dike: E - 533760; N - 4818140
Construction Dates:	1906-1908, 1911, 1938
Present Owner:	U.S. Department of the Interior, Bureau of Reclamation
Present Use:	Embankments impounding Lake Lowell, a reservoir storing water for irrigation
Significance:	The Deer Flat Embankments, which impound Lake Lowell, are significant as the first large storage feature built by the U.S. Reclamation Service on the Boise Project, one of the largest of the early projects undertaken by the Federal Government following the passage of the Reclamation Act of 1902. The Boise Project is also significant in the historic development of south-central Idaho because it finally fulfilled the tremendous irrigation potential in the Boise Valley, which had been recognized, but unsuccessfully developed, by private entrepreneurs. Today the Boise Valley is one of the great areas of irrigated agriculture in the Pacific Northwest, and that agricultural base has provided the foundation for the Boise-area economy. The Deer Flat Embankments are earthfill structures which represent conventional embankment design and construction methods of the early 20th century. Inadequate resistance to the erosive action of waves on the reservoir has caused repeated deterioration of the upstream faces of the embankments, leading to significant construction activity by the Civilian Conservation Corps in the 1930s.
Historians:	Fredric L. Quivik, Architectural Historian, and Amy Slaton, Historian, Renewable Technologies, Inc., Butte, MT

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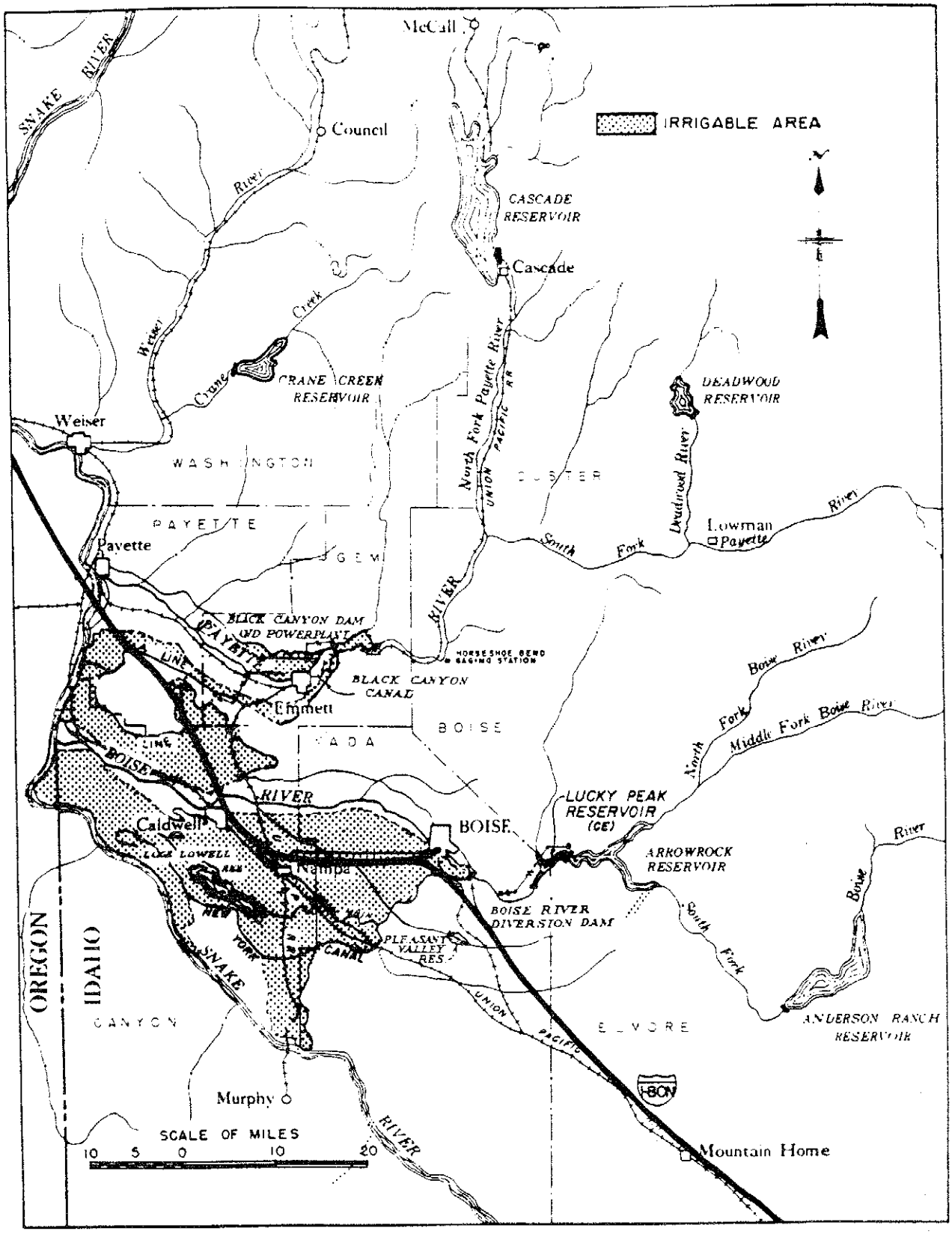
OPERATIONAL CONTEXT AND PHYSICAL DESCRIPTION OF THE DEER FLAT EMBANKMENTS

Operation of Lake Lowell in the Context of the Boise Project

Lake Lowell is an off-stream reservoir impounded by the Deer Flat Embankments to store water from the Boise River as part of the Boise Irrigation Project (see map on page 4). The reservoir is located about 4-1/2 miles southwest of Nampa, Idaho. The Boise Irrigation Project is divided into two divisions: the Arrowrock and the Payette. Lake Lowell is one of the storage features of the Arrowrock Division, which irrigates lands approximately comprising the southern portion of the project. The other storage features are Lucky Peak Dam (built by the Corps of Engineers for flood control), Arrowrock Dam, and Anderson Ranch Dam. Structures associated with the Payette Division include Black Canyon Dam, Deadwood Dam, and Cascade Dam. Total available storage on the project is 1,157,000 acre-feet, of which Lake Lowell provides 169,000. Reservoirs on the Arrowrock Division supply water to five irrigation districts which are part of the Boise Project as well as to eleven other districts. The five districts of the Boise Project are the New York, Boise-Kuna, Nampa-Meridian, Wilder, and Big Bend.

As an off-stream reservoir, Lake Lowell receives its supply of water from the Boise River by means of the Boise River Diversion Dam and the New York Canal. Located about four miles upstream (southeast) from the City of Boise, the Diversion Dam does not provide any meaningful storage; its purpose is to divert water from the Boise River into the New York Canal. Lake Lowell in turn feeds four canals. The outlet works supplying those canals are located at the two largest of the Deer Flat



Boise Project

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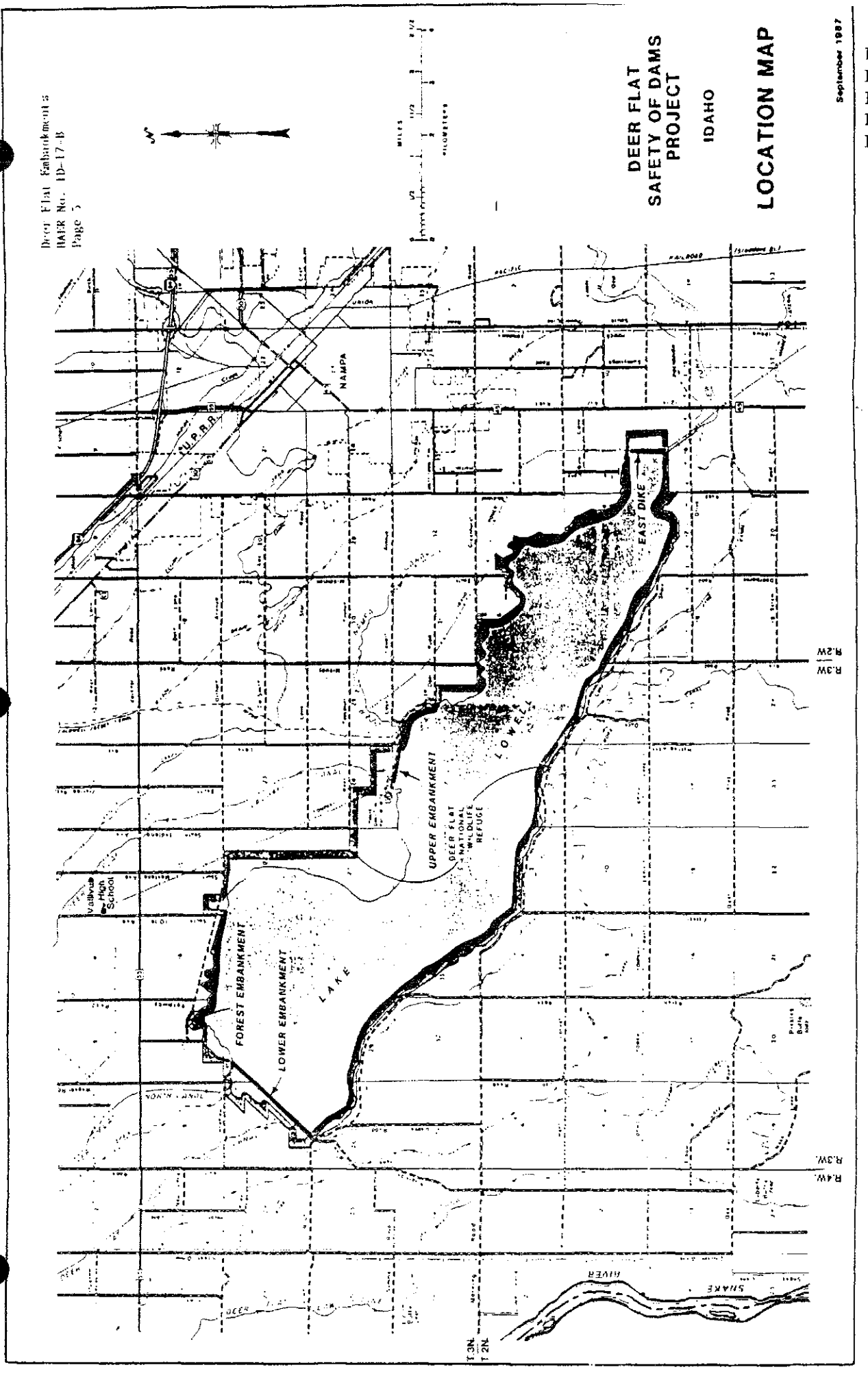


Embankments, known as the Upper Embankment and the Lower Embankment. During the irrigating season, the New York Canal supplies some water for canals and laterals which feed directly out of the New York Canal; the excess water flows into Lake Lowell. During the off-season, the Diversion Dam continues to supply water to the New York Canal, all of which is used to refill Lake Lowell.

Currently, the five Boise Project districts comprising the Arrowrock Division receive their water from canals associated with Lake Lowell as follows: 1) the New York Canal serves the New York, Boise-Kuna, Nampa-Meridian, and Wilder Districts, either by means of laterals leading directly from the New York Canal or by means of the Mora and the Deer Flat High-Line Canals, which head at the New York Canal; 2) the Deer Flat Nampa Canal, which emanates from the east end of the Upper Embankment, serves the Nampa-Meridian District; 3) the Deer Flat Caldwell Canal, which flows from outlet works at the west end of the Upper Embankment, serves the Wilder and the Nampa-Meridian Districts; 4) the Deer Flat North Canal, with outlet works at the north end of the Lower Embankment, also serves the Wilder and the Nampa-Meridian Districts; and 5) the Deer Flat Low-Line Canal, which emanates from the south end of the Lower Embankment, serves the Big Bend, Wilder, and Nampa-Meridian Districts. By means of the Notus Feeder Canal, some water from Lake Lowell also serves lands in the Black Canyon District of the Payette Division. The Settlers Irrigation District is an example of a district which is not part of the Boise Project but draws water from project reservoirs. The district lies within the boundaries of the Boise Project and receives water by prior right. Other districts lie outside the project boundaries, but under agreements with the Federal

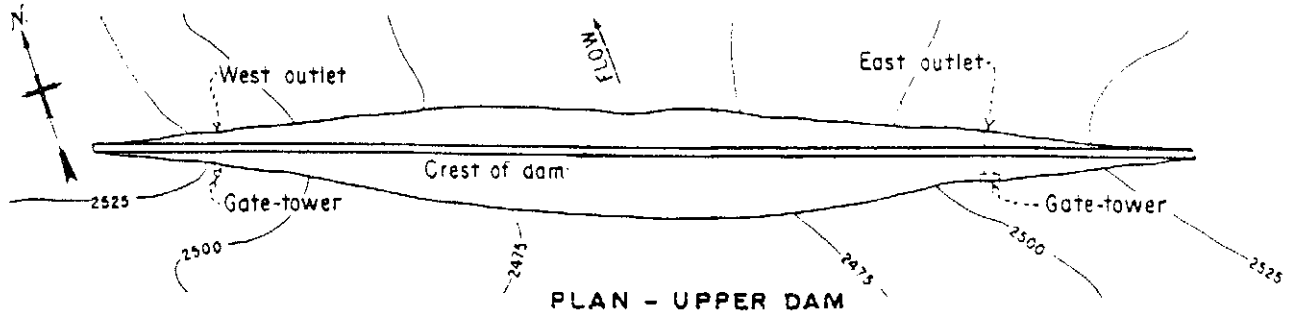
Government may purchase water when the three reservoirs in the Arrowrock Division (Lake Lowell, Arrowrock, and Anderson Ranch) are full.[1]

Because the reservoirs of the Arrowrock Division supply water to irrigation districts in addition to those which comprise the Boise Project, and because some of those districts take their water directly from the Boise River below the Diversion Dam, distribution of water during the irrigation season is more complex than on Reclamation projects which do not supply additional users. All of the irrigation districts employ ditchriders who daily travel along the canals and laterals to regulate the supply of water to individual farmers' ditches. At the end of the day, each ditchrider picks up orders from farmers for the water they will want the next day. Each district then submits its total order to the Boise River Water Master, who works for the State of Idaho. Early the next morning, the Water Master telephones the Corps of Engineers at Lucky Peak Dam with the total amount of water which the Corps needs to discharge and telephones the operator at the Diversion Dam with two totals: the amount that should pass over the dam for use by districts which take their water from the river below the dam and the amount that should be diverted into the New York Canal. Accordingly, operators at Lucky Peak and the Diversion Dam adjust their outlet works and head gates, respectively. That same morning, ditchriders make adjustments at the turnout gates along the New York Canal and its laterals to satisfy the orders made by the farmers the day before. Ditchriders on the canals below Deer Flat Embankments do the same thing, but the water they are supplying comes principally from storage in Lake Lowell rather than from the New York Canal. In the afternoon, the ditchriders obtain the next day's orders from the farmers.

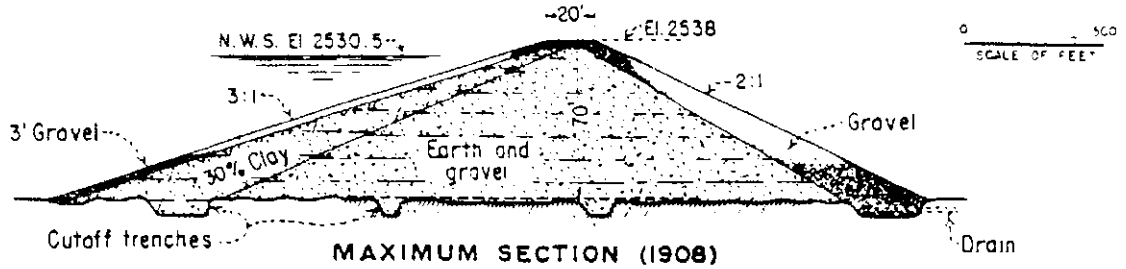
Physical Description of the Deer Flat Embankments

Lake Lowell is an off-stream reservoir about eight miles long from the southeast, where its inlet is located, to northwest, where it reaches a width of about three miles (see map on page 5). The reservoir is impounded by three earthfill embankments and a dike, known collectively as the Deer Flat Embankments. The two major structures are the Upper Embankment, midway along the north side of the lake, and the Lower Embankment, at the west end. The two lesser features are barely discernable: the Forest (also called Middle) Embankment along a low point on the north rim of the reservoir is just to the northeast of the Lower Embankment; the East Dike is at the east end of the lake adjacent to the inlet channel. The three embankments are zoned, rolled earthfill structures with impervious cores and gravel zones both upstream and downstream. (Zones in an embankment refer to distinct portions of the fill which have different qualities categorized by permeability. An impervious zone will not allow water to pass through it.) Lake Lowell covers about 9,835 acres, has a high-water elevation of 2,531 feet above sea level, and has a capacity of 190,100 acre-feet, of which 169,000 is active capacity.

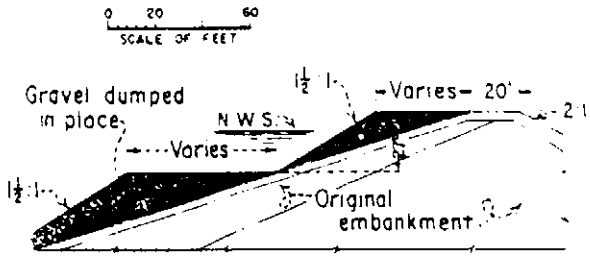
Although the three embankments are similar in their general structural composition, each is distinct in detail. At the time of documentation (1990), the Lower Embankment had a maximum structural height of 46 feet, a crest width of 45 feet, and a length of 7,270 feet (see plans on page 9). The base at its maximum width is about 220 feet. The impervious zone consists of earth and gravel placed in 6-inch layers and compacted with concrete rollers. An upstream portion of the zone has a 30% clay content. The downstream zone consists of gravel, is thicker at



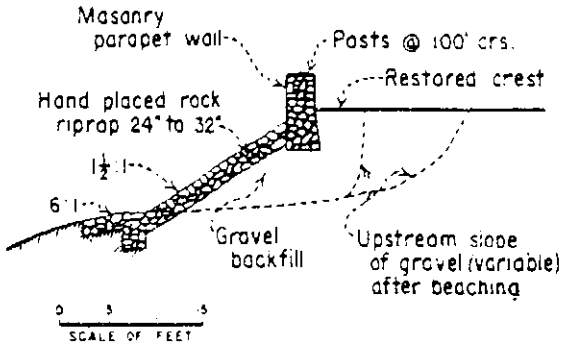
PLAN - UPPER DAM



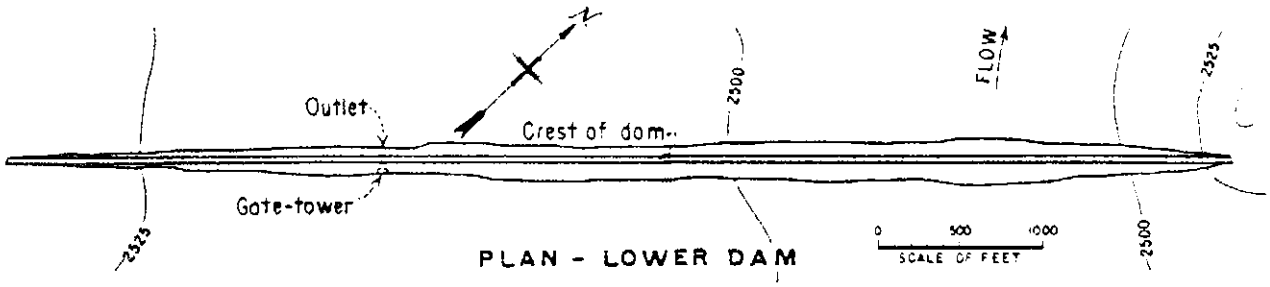
MAXIMUM SECTION (1908)



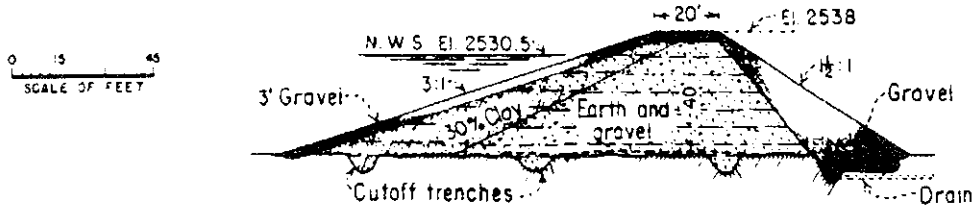
GRAVEL SLOPE PROTECTION (1911)
(Both dams)



SLOPE AND CREST PROTECTION (1938)
(Both dams)



PLAN - LOWER DAM



MAXIMUM SECTION (1908)

Deer Flat Upper and Lower Dams, Plans and Sections

the base than near the crest, and has a downstream face with a slope of 1-1/2:1. The upstream face consists of hand-placed rock riprap between 24 inches and 32 inches deep yielding an upstream face with a 1-1/2:1 slope. There is gravel backfill between the upstream face and the high-clay zone. Because of erosion to the upstream face, it has been rebuilt twice (1911 and 1938). The foundation consists of three cut-off trenches--two under the earth-and-gravel portion of the impervious zone and one under the high-clay portion--dug into the plain on which the embankment was built. Those soils are hardpan underlain with sand and clay.

The upstream face of the Lower Embankment originally consisted of gravel placed over the high-clay zone. The face was three feet thick from the base of the embankment to the crest and had a slope of 3:1. As soon as Reclamation began to fill the reservoir in 1909, engineers recognized the action of water against the upstream face was eroding the gravel, so in 1911 they decided to add more gravel to the upstream face. Although this improved the situation, the upstream face continued to erode and by the 1930s portions of the crest had been breached. In 1936-37, the Bureau of Reclamation had the Civilian Conservation Corps (CCC) rebuild the upstream face by placing riprap of rock 24 inches to 32 inches in breadth at a slope of 1-1/2:1. In addition, the CCC built a rubble-stone parapet along the top edge of the riprap (see page 9). The parapet is 24 inches tall and 24 inches wide, punctuated by 36-inch-high pedestals every 100 feet. The pedestals consist of 2-foot cubes of stone set 12 inches into the parapet. Each cube has a stationing number carved into its downstream face, beginning with the number "1" at the north end and increasing to "67" a the south end. The tops of the

pedestals are decorated with radial patterns of small cobble stones set in mortar (see HAER photos no. ID-17-B-5 to ID-17-B-9).

Erosion has continued over the years and water action has again carried away some sections of the upstream face, especially in the area between pedestal 8 and 10. Associated erosion has also damaged segments of the parapet in lengths ranging from about 10 to 30 feet. Damaged lengths are located between pedestals 8 and 9, 9 and 10, 17 and 18, 22 and 23, 23 and 24, and 25 and 26. Pedestals 5,6, and 7 are gone completely. Pedestals 1 and 2 along with adjoining sections of parapet were completely rebuilt by the Job Corps Conservation Corps (JCCC) in 1975. This most recent project also included a stone monument at the north end bearing an earlier plaque dedicating the lake to J.H. Lowell, an early State Irrigation Commissioner and promoter of the Boise Project, and a new plaque commemorating the work of the JCCC.

The Lower Embankment is equipped with two sets of outlet works, one near the south end and one near the north end (see HAER photo no. ID-17-B-78). The outlet works near the south end serve the Deer Flat Low Line Canal. They consist of a concrete gate tower at the upstream toe of the embankment and a concrete conduit which passes beneath the embankment to discharge into the canal at the downstream toe. Three steel sliding gates are set in the base of the gate tower, which extends above the surface of the reservoir to support an operator's platform. On this platform are three screw-stem hoists, one for each gate. The hoists have been modified with the addition of large, spoked wheels to make it easier for operators to turn the hoists. Cast decorative brackets and blind arches appear to support the

cantilevered edges of the platform and divide the tower into three bays, one for each gate. The gate tower has been modified with new concrete encasing the base as high as the spring-line of the blind arches. A steel-stringer pedestrian bridge provides access from the crest of the embankment to the operator's platform. A gas-pipe railing extends along both sides of the bridge and around the perimeter of the platform. Two large stones in the shape of the state of Idaho, fashioned by the CCC crews, stand along the parapet at either side of the portal to the bridge. The bridge has been modified with the addition of a sheet steel barricade with a locked door intended to prevent unauthorized access to the gate controls. The alterations to the tower, bridge, and hoists were made in the early 1960s.[2] Although original engineering drawings show a canopy with a hipped roof over the tower, early photographs indicate that the canopy was never built (see HAER photos no. ID-17-B-54, ID-17-B-77, and ID-17-B-78). An early construction report confirms that the plans for the canopy were changed during construction, but the report offers no explanation.[3]

At the north end of the Lower Embankment are the controls for the North Canal outlet works. They were built during the winter of 1959-60 and are located in a corrugated steel shed adjacent to the parapet along the crest of the embankment near the JCCC-built monument. Prior to the installation of the North Canal outlet words, the North Canal received its water by means of a siphon and a flume located at the Forest or Middle Embankment.[4] Neither the flume nor the siphon survive.

The Upper Embankment has a maximum structural height of 74 feet, a crest width of 35 feet, and a length of 4,164 feet. The base is about 400 feet wide at its maximum. Like the Lower Embankment, the impervious zone of the Upper Embankment consists of earth and gravel placed in 6-inch layers and compacted with concrete rollers. The upstream portion of the zone has a higher clay content. The downstream zone consists of gravel, is thicker at the base than near the crest, and has a downstream face with a slope of 2:1. The upstream face of the embankment consists of hand-placed rock riprap between 24 inches and 32 inches deep yielding an upstream face with a 1-1/2:1 slope. The foundation consists of three cut-off trenches--two under the earth-and-gravel portion of the impervious zone and one under the high-clay portion--dug into the plain on which the embankment was built. Those soils are hardpan underlain with sand and clay.

The upstream zone was originally gravel, three feet thick from base to crest and with a slope of 3:1 (see plans on page 9). When the reservoir filled, the upstream face of the Upper Embankment sustained the same erosion as that of the Lower Embankment, so it received a similar gravel treatment in 1911. In 1937-38, after work on the upstream face of the Lower Embankment was completed, the Bureau of Reclamation had the CCC rebuild the upstream face of the Upper Embankment by hand placing riprap, rock 24 inches to 32 inches in breadth at a slope of 1-1/2:1. The CCC also built a rubble-stone parapet, but it differs from the parapet on the Lower Embankment. The Upper Embankment parapet is 12 inches tall and 24 inches wide. It has pedestals every 100 feet, but they rise only about 10 inches above the parapet, are about 20 inches square, and consist of numerous small cobbles. The pedestal at the west end is taller than the others and has "CCC 1939" cast into its concrete base.

The Upper Embankment is equipped with two sets of outlet works, one near the east end and one near the west end. The outlet works near the east end serve the Deer Flat Nampa Canal. The design of the east-end gate tower and its steel-stringer approach bridge is virtually identical to that of the tower at the Lower Embankment (see HAER photos no. ID-17-B-70, ID-17-B-71, and ID-17-B-81). The concrete gate tower, which stands at the upstream toe of the embankment, originally held four sliding steel gates. Two of the gates and their corresponding conduits have been taken out of service. The manually-operated hoists for the two remaining gates are at the east end of the gate tower and are enclosed by a chain-link fence. As with the hoists at the Lower Embankment, those at the east end of the Upper Embankment have been modified with the addition of large spoked wheels. A corrugated steel shed sits at the west end of the gate tower and houses a lake elevation gauge. A small vehicular bridge with a rubble stone parapet (similar to that along the crest of the embankment) crosses the discharge portal of the outlet conduits, the west two of which have been plugged with concrete.

The outlet works near the west end of the Upper Embankment serve the Deer Flat Caldwell Canal and consist of a concrete gate tower with one sliding steel gate. Original plans called for the base of this gate tower to be cylindrical. Early photographs indicate, however, that the Reclamation Service built a rectangular tower with brackets and blind arches under the operator's platform, nearly identical to the gate towers for the Deer Flat Nampa Canal and the Deer Flat Low Line Canals, described above (see HAER photos no. ID-17-B-69, ID-17-B-82). The hoist for the gate has been enclosed in a corrugated steel shed. Unlike the other gate towers, this one is accessed by

means of a concrete stringer pedestrian bridge. Although the concrete-stringer approach bridge differs from the bridges to the other two gate towers, early photos indicate that it, too, is original. Alterations to the outlet works at the Upper Embankment were made in the early 1950s.[5] Unlike the gate tower at the Lower Embankment, however, the gate towers at the Upper Embankment have not been encased in concrete. The buttresses supporting the brackets and blind arches beneath the cantilevered operator's platforms clearly exhibit visual characteristics typical of early Reclamation Service concrete structures.

The Middle Embankment, which serves as the emergency spillway for the reservoir, has a height of 16 feet and a length of 950 feet. Because Lake Lowell is an off-stream reservoir, it does not need a conventional spillway. Virtually the only source of water to the reservoir is the New York Canal, and its flow can be controlled. The natural watershed of the basin comprising the reservoir adds a negligible supply of water. Because there is little possibility of the level of Lake Lowell rising above that determined by the operators, the reservoir is not equipped with a conventional spillway. The crest of the Middle Embankment is half a foot lower in elevation than the other embankments and is designed to serve as an emergency spillway. Its crest consists of the paved road known as Orchard Avenue. Like the other two embankments, it is a zoned earthfill structure, but because it is not very high and because of the paved road along its crest, it is barely discernable as an embankment.

Little information is available concerning the East Dike, other than that it was built in 1911 at the same time as the Middle Embankment. Bureau of Reclamation records do not identify

whether it is of zoned earthfill construction or simply a non-engineered dike. Likewise, the dike does not reveal much visual information about itself; rather, it appears to be little more than a slightly elevated but otherwise unimproved vehicular road. If Lake Lowell were to be filled to the stated high water level elevation of 2530.5 feet, then, according to topographic maps, water would back up to the East Dike. Early maps, however, do not show water extending as far as the East Dike. Moreover, the alluvial area between the dike and the water's edge--about a mile west of the dike--supports mature trees and dense underbrush. These facts suggest that the East Dike has rarely, if ever, served to impound water. When walking along the dike, it has no visual relationship to the reservoir.

The inlet channel for Lake Lowell is now about 1-1/2 miles long, flowing from southeast to northwest. The inlet channel begins at the inlet structure at the downstream end of the New York Canal about a half-mile southeast of the south end of the East Dike. Along this section, the inlet channel is about 50 feet wide, has steep banks of rubble-stone riprap, and conveys a rather rapidly-flowing stream. There are large boulders strewn along the bed of this segment of the channel, perhaps intended to dissipate energy embodied in the water as it drops from the inlet structure. The inlet channel extends another mile from the East Dike through the alluvial area to the east end of the reservoir. Along this latter segment of the channel, water moves quite slowly along a meandering route between low, non-engineered banks.

The inlet structure serves as a bifurcation works, dividing water in the New York Canal between the inlet channel and the Deer Flat High-Line Canal, which flows to the west. Concrete

abutments and piers support a narrow pedestrian bridge across the structure. Two sets of steel sliding gates (one about 8 feet wide and one about 16 feet wide), a radial gate (about 8 feet wide), and two spillway sections (each about 8 feet wide) are situated between the piers and abutments. The elevation difference between the crest of the spillway sections and the inlet channel is about 18 feet. The inlet structure has sustained minor changes since its original construction: sliding gates were replaced to create the spillway section, and the radial gate is a rather recent replacement of another sliding gate. Just below the Lake Lowell inlet structure are two other inlets, one on each side, which discharge drainage water from irrigated fields back into Lake Lowell.

Lake Lowell and its surrounding wetlands and uplands comprise fish and migratory waterfowl habitat managed by the U.S. Fish and Wildlife Service as the Deer Flat National Wildlife Refuge. Large stone monuments, built by the CCC in the late 1930s of stone similar to that used on the embankment parapets, mark the boundaries of the refuge. The refuge headquarters is located at the west end of the Upper Embankment. The gravel parking lot serving a boat ramp at the west end of the Upper Embankment has a series of stone monuments surrounding it. These were built by the JCCC in the 1970s of stone similar to that used for the monument at the north end of the Lower Embankment. There are also a large paved parking lot and a boat ramp at the east end of the Upper Embankment. Lake Lowell is a popular site for boating, fishing, and other water sports. The embankments near the gate towers are especially popular spots for fishing. About 200,000 people visit Lake Lowell each year.

Near the south end of the Lower Embankment is a camp used by crews of the Board of Control's Lake Lowell Division of the Boise Project for the operation of the outlet works, the canals and laterals. The camp consists of a dozen or so structures including dwellings, office, garages, and sheds, many of which appear to have been built in the 1910s or 1920s.

HISTORICAL BACKGROUND FOR THE BOISE PROJECT

Early Irrigation in the Boise Valley

The Boise River, an Idaho tributary of the Snake River, flows out of the mountains north and east of Boise and onto a broad plain south and west of the city. The plain is bordered on the south by a series of benches and on the north by a high mountain range. Known as the Boise Valley, the plain widens gradually to about fifty miles across where it meets the Snake River plateau thirty miles west of Boise.

The soil of the valley is extremely fertile. As with the nearby valleys of the Snake and Payette Rivers, the Boise River Valley's soil is composed of volcanic ash mixed with lava and the sand and gravel of glacial moraines. Temperatures in the valley are moderate, with little danger of killing frosts in late spring or early fall. Precipitation in the area, however, averages about 13-1/2 inches per year, indicating clear, sunny growing seasons. The climate suggests the potential for agriculture based on an irrigation system drawing water from a river swelled by melting snows in the spring and early summer but with considerably diminished flow from late summer through winter.[6]

The first irrigated farming in the Boise Valley dates from the formation of Fort Boise in the 1840s, a fur trading post of the Hudson's Bay Company at the confluence of the Boise and Snake Rivers. Population in the valley did not increase, however, until 1862, when prospectors discovered gold in the headwaters of the Boise River. Within a year, the population of the valley swelled to almost 20,000, creating profitable new markets for

farmers and ranchers. By the time the city of Boise was founded in 1864, three canal companies were operating a total of twenty-one miles of canals in the valley.[7]

Agricultural development in the valley expanded rapidly as the possibilities for successful farming of fruit and other crops near the Boise River became evident. The eight claims on Boise River water filed by the end of 1864 had grown to 29 by the following year, and to 51 by 1870. These early irrigation efforts involved the construction of sloughs taking water from the river to bottomlands on either bank. As farmers brought lands under cultivation at greater distances from the river, they increased the volume of water diverted into the sloughs by building crude diversion dams of brush or straw. Eventually they added headgates to control flow into subsidiary ditches. Because dirt embankments and ditches eroded easily, farmers cooperated to build more durable structures. Businessmen also responded to expanding agriculture by forming irrigation companies to build irrigation works and supply farmers with water. Among the first businessmen to initiate development of Boise Valley irrigation systems was William S. Morris. In 1873, Morris enlarged a canal first built in 1865 to carry logs to a Boise sawmill. This waterway became the Ridenbaugh Canal when Morris' nephew William Ridenbaugh took over its ownership. The canal was sold in 1890 to the Boise Land and Irrigation Company.[8]

The irregular flow of the river became an ever greater problem as more farmers sought to irrigate lands in the valley. Water was commonly taken from the Boise River on a "first in time, first in right" basis. The first user to take water from a stream was entitled to all he cared to take, and the next user to any water left over after diversion by the first user, and so on.

In most years, by the beginning of July, only the few users closest to the river were receiving any water at all for irrigation. The way water needed to be used in arid Idaho put strains on traditional legal means of establishing water rights.

Common in England and the eastern United States, the riparian doctrine stipulated that the owner of the land across which a watercourse flowed had rights to the water therein. Implicit in the doctrine was the requirement that the user return the water in like quality and quantity to the watercourse. The riparian doctrine was inappropriate in the arid West because users needed water for irrigation and therefore could not return it to the watercourse. Moreover, some lands suitable for farming were not adjacent to a watercourse. In the Boise Valley, irrigators' and miners' water claims were posted and filed with the local government, but there was no central office of record, nor any means to prevent infringement other than by court decrees or violent confrontation. The 1889 State Constitution of Idaho included the provision that the water of streams belonged to the state, but this was no more enforceable than any other notion of water ownership. In 1890, the supremacy of prior claims over riparian right was made official by the Idaho State Supreme Court, but by the end of the decade, claims had been filed for many times the actual amount of water in the Boise River. There was simply not enough water to go around.[9]

Developers knew that, to solve part of their problem, they could build reservoirs to store water from the spring and early-summer snow-melt in the mountains for use later in the growing season when flow in the Boise River was lower. But to make the problem more complex, many of the lands suitable for irrigation were not located along the river bottom and so could not be

watered by the simple diversions already in place in the valley. Irrigating such areas would require diversions farther up the Boise River where the elevation was such that water could be conveyed by canal to the lands to be irrigated. Such a canal system could be costly. Individuals and even groups of farmers had neither the money nor the engineering expertise to overcome these difficulties. Outside capital was needed to carry irrigation networks beyond the lowlands.[10]

Events in 1881 brought a sizable influx of capital to the region. The arrival of railroad lines to Nampa and Caldwell to facilitate shipping to national markets, and the Idaho Legislature's publicizing the presence of placer gold along the Snake River stimulated outside investment in the Boise area. The quest for gold especially brought investment that would benefit irrigation as well. It was believed by local authorities that the best way to recover the gold would be by running Boise River water down through the bench lands of the valley into the Snake River area. A canal constructed for this purpose could also bring its builders revenue from irrigation. John H. Burns of New York City filed for 150,000 miner's inches of Boise River water in 1882, intending to build one canal along the east end of the valley and another along the west end. Both would be owned by the Idaho Mining and Irrigation Company.[11]

The canal at the east end of the valley, known as the New York Canal, was surveyed in 1883 by A.D. Foote, chief engineer and manager of the project. He laid plans for a canal that would carry 4,500 second-feet of water to irrigate 500,000 acres. Some minor construction work was begun, but financial and engineering problems held the project back for the rest of the decade. The canal project was taken over soon after its initiation by another

private firm from the East and named the Phyllis Canal, after the daughter of one of the developers. Difficulties in obtaining water rights and funding, engendered in part by the obvious lack of progress on the New York Canal, slowed the Phyllis. Meanwhile, work on further enlarging the old Ridenbaugh Canal, also at the west end of the valley, was undertaken by its new owners, the Boise and Nampa Canal Company. The directors of this firm were all either officers or directors of the Idaho Central Railroad. The Ridenbaugh also bogged down over issues of land and water rights, and was sold two more times before reaching a degree of completion allowing water deliveries to the town of Nampa in 1890. Earlier that year, the Phyllis Canal had finally reached the west side of Nampa after seven years of intermittent progress.[12]

Back on the east end of the valley, the New York Canal project was at a virtual standstill. A mere six miles were completed during 1891 by the Bradbury Company, and the project was ultimately sold in 1896 to a group of farmers who managed to build and operate a shorter version of the canal along the north side of the Boise River. In 1902, the frequent, but generally troubled efforts of private capital to develop large irrigation systems in the Boise Valley were displaced by the massive initiatives of the Federal Government under the newly formed United States Reclamation Service.[13] Local optimism coupled with federal capital and the design expertise of the federal engineers eventually led to a prosperous agricultural economy in the Boise Valley. At the dedication of the giant Arrowrock Dam on the upper Boise River in 1915, promoter J.H. Lowell recalled the foundation laid by the early entrepreneurs: "Some of these

enterprises were ahead of their time; all of them had hard sledding as irrigation investments, but wherever they succeeded in putting water on the land the farmer and the homemaker made good."[14]

Background of the Reclamation Act

Government involvement in Western land development had escalated slowly after the Civil War. The Homestead Act of 1862 allowed each person to claim 160 acres of land opened for settlement (a husband and wife could claim 320). With ample rainfall, this amount of land could support a family, but in drier regions a family would have difficulty earning its livelihood from such an acreage. Recognizing this inadequacy, Congress in 1877 passed the Desert Land Act, affecting thirteen western states. The act allowed each person to obtain 640 acres (reduced to 320 in 1890) for $1.25 an acre, with the purchaser's promise that a portion of the land would be irrigated within ten years. Prospective settlers claimed over a million acres in Idaho under this act. Such acts encouraged settlement in western lands, but did not address the problem of water supplies for irrigation farming. It was not until the last decade of the century that the Federal Government took positive steps toward sponsoring irrigation projects.[15]

John Wesley Powell, in the employ of the United States Geological Survey (USGS), had surveyed the west for possible water storage sites, publishing the Report on the Lands of the Arid Region in 1878. An 1890 article by Powell in Century Magazine estimated that as many as 120 million acres could be irrigated if the U.S. developed all of the reasonably available storage areas. Powell's optimism matched that of western

politicians like Idaho governor William J. McConnell, who felt that states should grant assistance for the building of reservoirs for irrigation purposes. This sentiment was part of a widespread boosterism of the "New West," seen in publications like Irrigation Age, launched in 1890 by an Omaha reporter, and National Irrigation Congresses started in 1891 and sponsored primarily by railroads. At the National Irrigation Congress of 1891, the gathered representatives of railroads, real estate groups, state land commissions, and irrigation companies adopted a resolution that proceeds from the sale of public lands be used to finance the large-scale reclamation of arid lands.[16]

The idea of a comprehensive, federal approach to reclamation reflected a national change in notions of how private and public enterprise should work. A trend in government policy towards the regulation of economic activities in many industries that were potentially monopolistic could be seen, and land management and reclamation were no exception. In 1890, the U.S. Census Office had asked F.H. Newell to conduct a census of irrigated farms. In his report, Newell described how most irrigation projects were implemented and maintained by individuals or small groups; he suggested that the result was a haphazard and inefficient system. He implied, thereby, that the Government could better manage reclamation efforts. Private, profit-oriented companies no longer seemed the only or optimum vehicle for creating reclamation projects.[17]

The Wright Law, enacted in California in 1891 and adopted by Idaho in 1895, paved the way for legal ownership of irrigation systems by irrigation districts, authorizing them to issue bonds for the construction of irrigation works. These locally-controlled districts could use the bonds as liens on the

irrigated lands and levy taxes to repay the bonds. The Andrews Law of 1897, limiting the power of private irrigation companies (prohibiting fixed charges and forced purchase of water) further eased the way for government and user-owned reclamation works.[18]

Of the legislative acts passed before 1902, the Carey Act was probably the most significant for the settlement of arid land in Idaho. Under this act, the Federal Government offered to transfer up to 1 million acres to each western state with the provision that not less than 20 acres of each 160-acre tract would be brought under cultivation within 5 years. Idaho accepted the Government's offer in 1895, eventually receiving 2 million acres beyond the original 1 million and becoming the state with the most Carey Act lands. Idaho was particularly successful in procuring lands in the south central portion of the state under the Carey Act.[19]

Despite the enthusiasm with which Idahoans applied for Carey Act lands, only 629,724 acres of the millions available in the state were ever patented. The familiar problem of a lack of capital to create adequate water storage facilities limited the possibilities for agricultural development. In 1901, the idea of providing federal aid to irrigation was debated in Congress. F.H. Newell, Dr. Elwood Mead of the Department of Agriculture, and Senator Francis Newlands of Nevada were particularly vocal proponents of the National Irrigation Congress concept of using revenues from the sale of public lands as capital to create large reclamation systems.[20]

Though objections were raised by some farming interests, who thought that bringing more lands under cultivation would lower already depressed farm prices, and by ranchers, who felt that

public lands should rightly go for cattle and sheep grazing, Congress passed the Reclamation Act in 1902. The purpose of the act was to develop reclamation projects. The Federal Government would actually construct the dams and carriage works necessary for such projects. With the support of President Theodore Roosevelt, an active conservationist and "New West" booster, the United States Reclamation Service (later the Bureau of Reclamation) was established, initially as part of the USGS, and later as a distinct agency of the Department of the Interior. The Reclamation Act, or Newlands Act as it was commonly known, set limits of 160 acres for claims on federally reclaimed land, prohibited non-resident ownership, and provided that charges for land use be calculated on the basis of returning the cost of projects to the reclamation fund. No interest would be charged to homesteaders. When all costs were returned, operation and maintenance of the projects would be turned over to irrigation districts representing the owners of the irrigated lands. Because the law applied to fiscal year 1900-1901, there was already almost $8 million in the fund by June of 1902, ready to be applied to irrigation projects in the sixteen arid western states that came under its authority.[21]

Preparing for Federal Involvement

It was apparent to settlers and developers that plans for the irrigation of the Boise Valley, even if conceived on a less grand scale than those of A.D. Foote, would require the construction of storage facilities. Landowners and those representing their interests seemed willing to cooperate with whichever funding agency might satisfy this need, whether state (through the Carey Act) or federal (through the Reclamation Act). D.W. Ross, working for the Reclamation Service as the engineer

directing project investigations in Idaho, J. H. Lowell, the State Irrigation Commissioner, and other prominent Boise citizens led a movement throughout 1903 and 1904 to attract federal funding to the Boise area.[22]

At the time of the passage of the Reclamation Act, a general outline for the Boise Project had been assembled from Foote's scheme and investigations by Ross. It was this new scheme, including works on the Payette River as well, that Ross promoted through press releases, lectures, and mass meetings in Nampa, Caldwell, and other towns. In response to those who objected to the idea of Reclamation Service involvement and who preferred to pursue less comprehensive plans like expanding the existing Ridenbaugh Canal, Ross and his associates responded that private capital could not hope to create facilities of the quality that government funds could. As a further incentive to opting for the larger, federally-funded scheme, they asserted that the greater the amount initially invested in land reclamation, the greater land values in the area would become.[23]

Ross and Lowell demonstrated that through a Reclamation Service project, the greatest practical and financial benefits would go to the greatest number of small farmers: speculators and non-resident owners would be prohibited from participating under the Reclamation Act. Lowell managed to register 1,509 land owners, representing 125,736 irrigable acres, for the project in a ten-week period. On March 27, 1904, Boise area citizens sent a formal 170-page request to the Secretary of the Interior asking that the Payette-Boise Project be undertaken.[24]

Before approval of the Boise Project could be obtained, the possibilities for appropriations from the Reclamation Fund had to

be resolved. The Minidoka Project on the Snake River had been selected as the first recipient of Reclamation Funds in Idaho, and it was unlikely that the Government would choose to support two large projects in the same state at the same time. Promoters of the Boise Project rallied their evidence and issued a special plea to the Reclamation Service that a portion of the Minidoka funds be set aside for Boise. They acknowledged the importance of the Minidoka Project for irrigating the entire upper Snake Valley and admitted that some work on the Minidoka Project must be commenced to prevent interested private developers from obtaining Minidoka water rights. The Government needed to retain its rights in that area "so that, by no mischance, the key of the situation on the upper [Snake] river could be snatched from its keeping." Yet, they argued, the Boise region, unlike the Minidoka region, was already settled; citizens were trying to earn a living from the land and desperately needed irrigation improvements. A letter signed by 100 residents of the Payette-Boise area was sent in April 1904 to the Secretary of the Interior suggesting that the Minidoka Project be "started without making immediate arrangements to complete it."[25]

In September of that year, the Payette-Boise Water Users Association signed formal articles of incorporation, with Lowell as president and D.R. Hubbard as treasurer. Organizers felt that there was a clear need for reservoirs in the area, both for the benefit of new development and existing farms. A statement of the Association's goals asserted that building storage facilities in the valley would not interfere with the rights of prior users of the Boise River, as some of those users claimed. Rather, the Association stated, storage facilities would "supplement rights hitherto acquired" and prevent "an interminable wrangle" over those rights. Local Reclamation official D.W. Ross strongly

supported the rapid formation of the Association because it would work to attract "people from the outside with plenty of means--people who are prepared to pay for all the advantages which an organized community and complete irrigation works can give." He disagreed with those in the Reclamation Service who felt that "public lands are already in the hands of those most deserving, mainly because they are poor," and thought the Water Users Association would place Boise Project land "into the hands of permanent settlers as speedily as possible."[26]

With more than 1,600 landowners pledging their lands, the official formation of the Payette-Boise Water Users Association indicated to the Reclamation Service the willingness of Idaho residents to take on the debts associated with a federal project. On March 27, 1905, the Secretary of the Interior authorized the Payette-Boise Project. Reclamation shifted half of the $2,600,000 allotted for the construction of Minidoka Project features to the Payette-Boise Project. Because federal funds could be used only to build works that would irrigate new lands, the water users on the Boise Project still had to purchase the Ridenbaugh Canal--needed for the planned Boise system--with their own funds. They were reluctant to do so, but a drought in the summer of 1905, and Ross' insistence turned the tide of opinion. He argued that failure of the users to purchase the canal "will very likely lead to the abandonment of the government reclamation enterprise, for the interest of the government in this undertaking is not likely to be greater than the interest of those who would be beneficiaries under the plans proposed." Water users approved the bond issue for purchase of the Ridenbaugh Canal in April 1905.[27]

In 1903, shortly after the passage of the Reclamation Act, government surveyors had conducted preliminary surveys of the Payette and Boise valleys, following which the Reclamation Service had announced that reclaiming about 300,000 acres in the area was feasible. A necessary feature of any enlarged irrigation project in the Boise Valley would have to be a storage reservoir. The report of the first survey noted the potential for off-stream water storage at Deer Flat, about four miles west of Nampa. As originally conceived, there would have been two distinct reservoirs. The dams contemplated in the report were to be placed where today's Upper Embankment and Lower Embankment are located. The originally-planned heights of 55 feet and 25 feet, respectively, would not quite have raised the water level in the reservoirs to the elevation of the small divide separating the two sub-basins (at heights of 74 feet and 46 feet, respectively, the two embankments actually built inundate that divide to create a single reservoir). Based on the surveys, the Director of the USGS authorized more detailed surveys of primary canal lines and dam sites in the two valleys. Surveyors under Ross' direction conducted these surveys between March and November 1904.[28]

The subsequent surveys showed that surrounding high ground, coupled with two higher manmade embankments, could impound a reservoir of over 9,000 acres. Further examining the area by digging test pits and drilling test holes, surveyors determined that the bottom of the basin would hold water and the hills near the proposed embankment sites were of a material suitable for constructing the embankments. Because the reservoir site was several miles from the Boise River, the Reclamation Service would have to develop a canal to convey water from the river to the reservoir. Engineers identified two potential routes for this canal, one along the existing Ridenbaugh Canal and the other

along the existing New York Canal. Both schemes would carry water to Indian Creek, along which it would flow for several miles and then be diverted into a new canal leading to Deer Flat. The engineers recommended that the New York Canal route would be superior because its higher elevation would allow it to supply subsidiary canals between the river and Indian Creek leading to higher ground than could be supplied from the Ridenbaugh Canal. The New York Canal also would offer fewer difficulties in arranging for the transfer of title than would the Ridenbaugh.[29]

By early 1905, Ross, with the aid of assistant engineers J.T. Burke, Charles B. Smith, and Gilbert H. Hogue, had prepared preliminary plans for the Payette-Boise Project. As originally conceived, there would be three divisions on the project: the Payette Division would irrigate lands in the Payette Valley as well as a portion of the lower Boise Valley; the Boise Division would irrigate lands between the Boise and Snake Rivers as well as lands north of the Boise River and upstream from Caldwell; and the Succor Creek Division which would pump water onto lands south of the Snake River using electricity generated at a dam on the Payette River (the Succor Creek Division has since become a part of the Owyhee Project).[30]

Having completed surveys of soil and sub-surface conditions throughout the proposed project area, Ross' engineers generated preliminary drawings for structures on the proposed project, expressing confidence that they were able to predict how the conditions would affect construction and construction costs. An advantage of the project would be that "none of the proposed works involve serious engineering difficulties in their construction." The engineers projected that the Payette Division would irrigate 72,000 acres at a cost of $2,887,400, or about $40

per acre. Smith and Hogue estimated that the much larger Boise Division would irrigate 274,000 acres at a cost of $6,222,900, or only about $23 per acre.[31] Thus, even though the Boise Division would require a greater expenditure, it was the more desirable first phase of the Payette-Boise Project because land could be brought under irrigation for little more than half the cost per acre of land in the Payette Division.

The $1,300,000 initially allotted for the Payette-Boise Project was far short of the total amount desired by its proponents, but it would allow a substantial start on the project. In November 1905, Reclamation Service investigators issued a report stating that work would begin with "the transfer to the United States by its owners, of the New York Canal," and construction of the necessary dams and other features to irrigate approximately 126,000 acres in the Boise Valley south of the river. Among the factors said to make this portion of the Boise Project feasible with the limited funds available would be the low price of the Deer Flat reservoir, offering storage for only $5 per acre-foot, and the granting, free of charge, of five miles of completed New York Canal to the project. The "gift" of the New York Canal was not so much a generous gesture by the canal's owners as a concession that any development under the canal was completely dependent on the government project because the canal company's own decreed rights to the Boise River water were so limited. Of the area to be irrigated by this first phase of the Payette-Boise Project, some 55,000 acres were wholly without irrigation at the time.[32]

DESIGN AND CONSTRUCTION OF THE BOISE PROJECT

Final Designs and the Call for Bids

By the end of October 1905, Ross and his engineers had completed final plans and specifications for the first phase of construction of the Payette-Boise Project. Ross summarized the proposed project as follows:

> The South Side Boise Division of the Payette-Boise Project provides for the construction of a dam in the Boise River near the mouth of the Boise canyon and a canal from the dam site to the proposed Deer Flat reservoir, a distance of 39 miles, and the construction of two earthen embankments on Deer Flat,[33] and a system of distributing canals from the reservoir.

Ross' estimate for the first phase of construction on the Payette-Boise Project was $1,612,250. That sum included $200,000 for constructing the Boise River Diversion Dam and the canal headworks, $253,000 for enlarging the New York Canal, $227,000 for extending the main canal from Indian Creek to the Deer Flat Reservoir, $772,250 for building the earth embankments and outlet works for the reservoir, and $160,000 for constructing the system of canals emanating from the reservoir. All estimates included costs for engineering and for contingencies. The estimate was over $300,000 more than had been allocated for the Payette-Boise Project. Ross rationalized this increased expenditure by citing the need for the $200,000 stone diversion dam in the Boise River at the head of the New York Canal, a need which had not been anticipated in the earlier cost estimates. He also pointed out that the cost of the main canal was $100,000 more than had earlier been estimated because of his recommendation that the

canal have an initial capacity of 1,500 second-feet, rather than 1,000 second-feet. A canal of less capacity would require enlargement soon after it was finished.[34]

In November 1905, the Project Board of Engineers recommended to the Chief Engineer of the Reclamation Service that the Government proceed with printing the final plans and specifications for construction of portions of the Boise Division and that the Government advertise for bids on that construction.[35] Ross divided the specifications into two phases of five schedules each. The schedules for the first phase included constructing the diversion dam and headworks; reworking the New York Canal from the headworks to Indian Creek; building the canal from Indian Creek to Deer Flat; constructing all of the structures along the canal such as bridges, turnouts, culverts, and drops; and installing all the steel gates and lifting mechanisms. Schedules for the second phase included: the Lower Embankment for the Deer Flat Reservoir; the Upper Embankment for same; the distributing canals; the structures along the canals; and steel gates and lifting mechanisms for the distributing canals.[36]

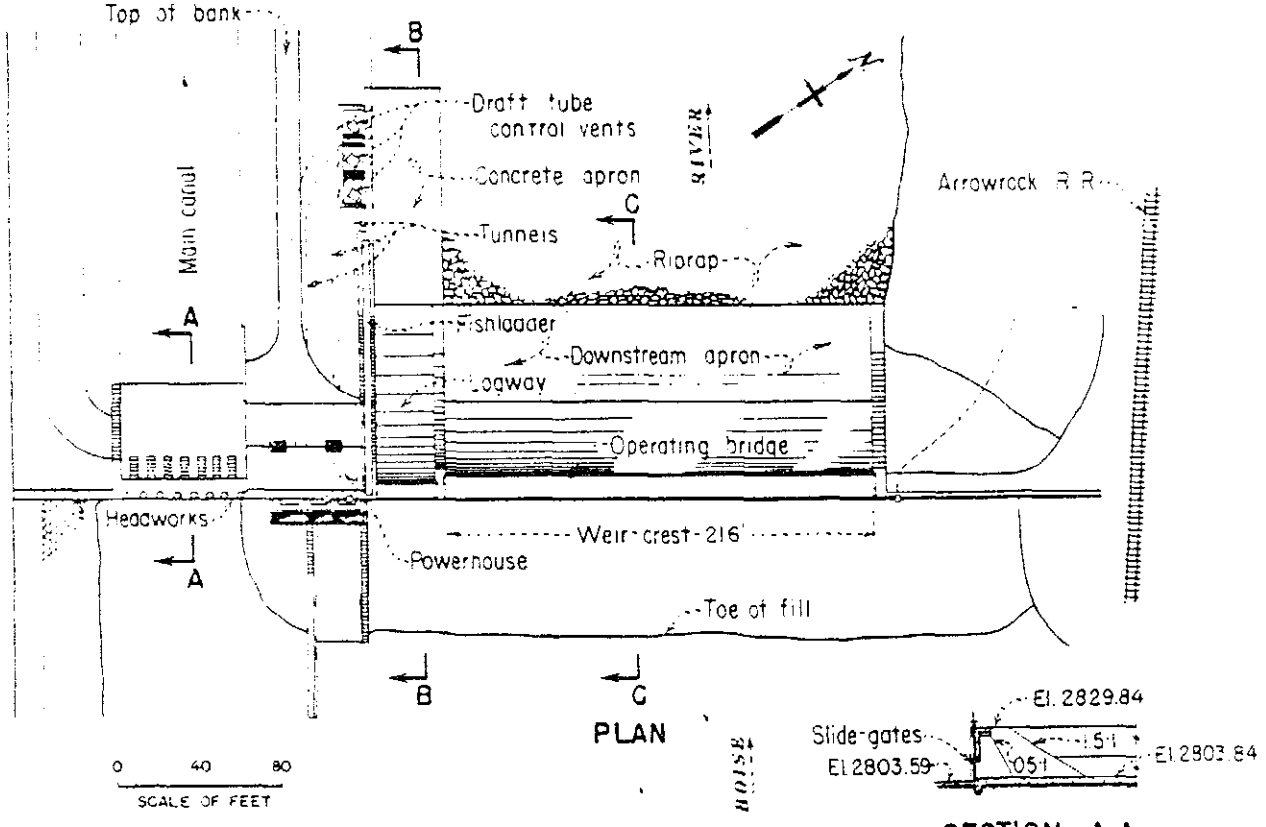
On December 28, 1905, the Secretary of the Interior announced that the Reclamation Service was seeking bids for the several schedules of the Payette-Boise Project construction, and that proposals would be opened on February 1, 1906. At the bid opening, however, the Government was disappointed at the response received from interested contractors. Few large or experienced firms bid on the work, an occurrence Reclamation engineers attributed to a situation in which "the industrial conditions were such that large contracting firms had all the work that they could handle."[37] Although it found the low bidders for most of

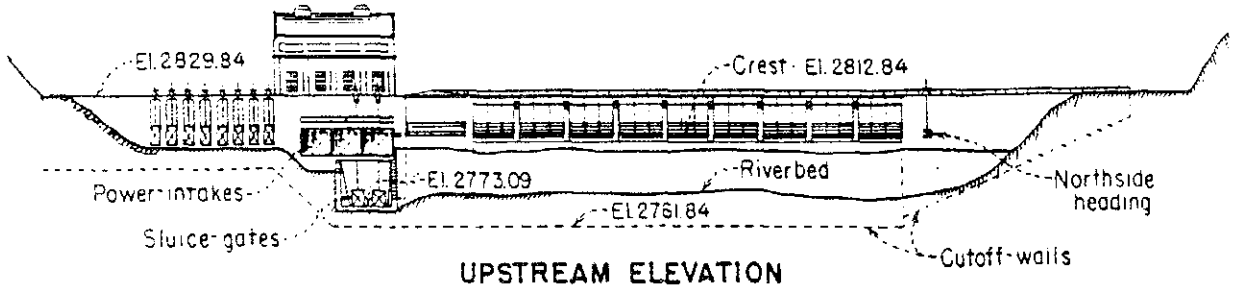
the schedules acceptable, the Board of Engineers recommended that bids for two of the schedules be rejected. For the reworking of the New York Canal between the diversion dam and Indian Creek, they recommended that the work be re-advertised as three smaller schedules. The Board recommended that the bids for construction of the Upper Embankment be rejected outright and that the work be undertaken by the Reclamation Service under "force account" (meaning that the Government would hire its own workers to perform the construction).

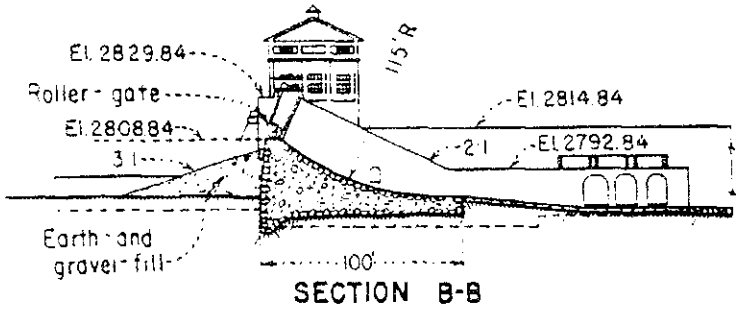
Despite the restructuring of the schedules in an attempt to achieve satisfactory results, the Reclamation Service experienced difficulty in getting much of the work done on time. Moreover, some of the contractors went over budget, lost money, and filed claims against the Government in an attempt to recoup those losses. As it turned out, the absence of difficult terrain or unusual engineering challenges did not make the costs of the early phases of construction on the Payette-Boise Project predictable, as Ross had expected they would.

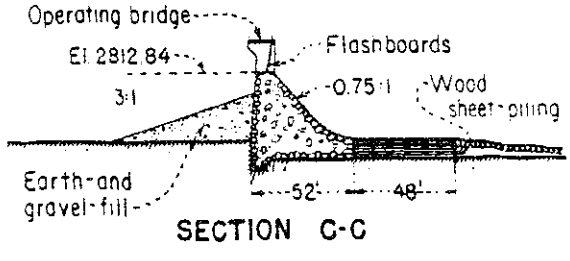
Boise River Diversion Dam

The Boise River Diversion Dam (see map on following page) was designed to be a overflow structure built of cyclopean concrete masonry with a thin rubble masonry face and a rock-filled timber-crib apron. (Cyclopean concrete masonry consisted, when cured, of a monolith of large rubble stones and cement. It is now known as mass concrete.) The crest of the spillway portion of the dam would be 250 feet long and 35 feet above the









Boise River Diversion Dam, Plan and Sections

river bed. At the left abutment, the headworks would consist of eight 5-foot by 9-foot sliding steel gates (see HAER photos no. ID-17-A-9, ID-17-A-34) for regulating the diversion of water into the New York Canal, the bottom of which would be 26 feet higher than the river bed. In addition to the dam and headworks, the completed structure would include a logway, a fish ladder, and a by-pass. The logway was designed to allow logs, which logging companies floated down the Boise River, to pass over the dam without doing damage to the structure. The design of the fish ladder consisted of a series of stepped pools 6 feet long, each one about 18 inches higher than the previous one, which would allow spawning fish to swim upstream past the dam. The by-pass would allow the dam tender to discharge water back into the Boise River if the river was not high enough to spill over the dam. Reclamation engineers had noted that the head developed by the diversion dam could also be used to generate electrical power for pumping water for irrigation onto higher lands or for other municipal or industrial purposes, but the engineers included no provisions for electrical generation in the original plans for the dam.[38]

The Reclamation Service opened bids for the various portions of the construction on February 1, 1906. Low bidder for the diversion dam and headworks was the Utah Fire Proofing Company of Salt Lake City at $156,950. The firm received a contract dated 21 February 1906, which specified that 20% of the work should be done by July 1 of that year and the project completed by April 1 of the following year. Construction began in March 1906, but by the end of August only 17% of the work was complete. Utah Fire Proofing had only completed 41% of the work by 1 April 1907, due in part to frequent high water which suspended progress on the dam. But a significant part of the delay was also due to the

company's inability to keep superintendents on the job. As work continued into 1908, the company's 16th superintendent was taking charge, and when the firm finally completed the dam and headworks in October 1908, at least 19 superintendents had been on the job. As a result of these delays, Utah Fire Proofing lost almost $90,000 on the contract.[39]

During the log drive of the following spring, the drive's foreman--acting "maliciously" according to the Reclamation Service--removed the boom above the dam intended to guide logs through the log pass. This allowed logs to spill over the main section of the dam, causing the destruction of the timber apron of the dam and consequently leading to severe erosion of the river bed just below the dam. The Reclamation Service made repairs to the dam and apron over the next three years at a cost of over $73,000.[40]

Construction of the Main Canal

The Reclamation Service planned to develop a canal from the Boise River Diversion Dam to the reservoir at Deer Flat by improving the existing New York Canal to Indian Creek and building a new canal from Indian Creek to the reservoir. Plans to improve the New York Canal consisted mainly of enlarging it to a bottom width of 40 feet. Sides of the canal would have a slope of 1-1/2:1 and it would have a capacity of 1,500 second-feet at a velocity of 3.6 feet per second. The first six miles of the canal below the diversion dam already had a wide section, so that portion of the canal needed only to be cleaned and repaired at a cost of $2,000 per mile. This work was done by government forces.

The remaining 19 miles of the New York Canal, however, needed extensive work to bring it up to the desired capacity. Average cost for enlarging the canal was about $10,000 per mile. Depending on the terrain traversed, some segments would cost less than $6,000 per mile to upgrade, while others would cost more than $17,000 per mile. Building the 12 miles of new canal from Indian Creek to Deer Flat would cost considerably more, ranging from less than $9,000 per mile to almost $40,000 per mile. Average cost of this newly constructed portion of the main canal was estimated at about $19,000 per mile. Most of the excavation would be accomplished by horse-drawn plows to loosen the material and horse-drawn scrapers to move it out of the channel of the canal and onto the berm (see HAER photos no. ID-17-A-39, ID-17-A-40). Where the ground was especially hard, contractors would have to break it apart with explosives before scraping.[41]

After the Reclamation Service received the first bids for reworking the New York Canal, the engineers decided to divide that work into three separate schedules and re-advertise for bids. Each schedule was for enlarging about six miles of the existing canal. William H. Thompson, a Boise Valley contractor, submitted the low bid for the length of canal just downstream of the portion being reworked by government forces. He began work in May 1906 and completed the contract in April 1908. Although the government reported no unusual problems with Thompson, he did have to excavate more earth than the engineers had estimated. Thus Thompson's contract cost the government $178,474, rather than the $93,149 which had been projected.[42]

The Reclamation Service awarded the remaining two schedules to Page and Brinton of Salt Lake City. The Page and Brinton contracts proved trying for the Reclamation engineers, despite

the confidence the Reclamation Service expressed in annual reports during the course of construction. When commenting later on the completed construction, Reclamation engineers attributed the difficulties with Page and Brinton to the fact that the contracting firm had just been formed, that neither partner had any previous contracting experience, and that Hubert Page, who actually supervised the work, "had training as an engineer but proved, during the progress of the work, his inability as a superintendent of construction." With all of the government contracts active in the Boise Valley, costs of equipment and supplies increased and labor became scarce. Many laborers left Page's employment after work was underway. In order to keep those who stayed, the contractor found that he had to pay them more than he had calculated in his bid. To make matters worse, he encountered harder ground than expected, making excavation more costly.[43]

In April 1907, the Government reclassified the work at the contractor's request, meaning that Page and Brinton would receive higher pay per volume of earth moved on account of the more difficult excavation. Still losing money on the contract, the contractor tried again to get the work reclassified as comparable to moving solid rock. Meanwhile, Page had fallen behind schedule. He was scheduled to have been finished with his work by March 1, 1908, but at that time he had completed only 83% of the work specified in the contract. When water was turned into the canal that April, he could no longer continue his work. At the conclusion of the irrigation season, the Reclamation Service ordered Page back to work. When he did not respond, the Government suspended the contract, confiscated the contractor's equipment, and had its own forces perform the work. Government forces finished the canal in January 1909. During the course of

the contract, the Government paid Page and Brinton $256,254, and the contractor reported a loss of $35,150. Rancor between Page and the Reclamation Service continued, however, and in 1913 he filed a claim against the United States for another $325,931.[44]

The contract for building the canal from Indian Creek to Deer Flat, on the other hand, went smoothly for the Reclamation Service and its contractor, Conway and Wilhite. Like Thompson, Conway and Wilhite was an experienced excavation contractor from the Boise Valley. Shortly after signing the contract, Conway and Wilhite went to work, completing the specified work within the allotted time. Moreover, the contractor made a healthy profit on the job, despite the high cost of equipment and supplies and the labor shortage. According to the Reclamation Service account:

> The labor on this contract amounted to nearly 80% of the total cost.....the greater part of the labor employed on this work belonged to the "hobo" class. Throughout the life of the contract labor as a rule was very scarce. All common "drunks" collected by the police force of Nampa were turned over to the contractors. Almost any one who would work was given a place, and therefore as a whole the labor was very inefficient. At times the contractor had teams standing idle for lack of drivers. Owing to the scarcity of labor, work was conducted on a 10-hour basis until the issuance of the Executive Order of September 19, 1906, when operations were adjusted to an 8-hour basis and continued on that basis to the close of the contract.[45]

For building the new section of canal, the Government paid Conway and Wilhite $224,629, of which $16,528 was profit. The contractor made additional profit on each subcontract (men with their own teams of livestock were paid as subcontractors). Reclamation engineers noted that the conditions under which Conway and Wilhite worked were nearly identical to those

confronting Page and Brinton. Reclamation believed that the difference between profit and loss for the two contractors was the practical experience possessed by the former. Blasting was a costly enterprise, so Conway and Wilhite applied their talents to devising ways of being able to plow and scrape even very hard ground instead of blasting. They purchased very heavy-duty equipment and adapted it in the field to make it better suited to the local conditions. On the other hand, the engineers believed that "Page and Brinton [were] educated men but theoretical and visionary. Their foremen were, in general, educated men, but not practical graders." In the opinion of the engineers, the contractor should have figured out how to plow and scrape hard ground. Instead, Page and Brinton used explosives and devoted their energies to trying to get the Government to change the classification of the work to a more remunerative category, losing money in the end.[46]

The irregular performance of contractors notwithstanding, the Reclamation Service was able to turn water into the canal for the 1909 irrigating season. The original plan had been to construct a canal with a 40-foot base to get the Boise Project operating. Later, as the acreage of the project grew, Reclamation would widen the canal to a final 70-foot width. Subsequent calculations, however, showed that for portions where the canal passed through deep cuts or along steep side hills it would be more practical to line the existing canal with concrete rather than widen it. Concrete lining would cost less than widening the canal again and would allow the Reclamation Service to run water at higher head through the canal without fear of erosion, thus reaching the desired increase in capacity from 1,500 second-feet to 2,200 second-feet. Further advantages of lining were that the risk of breaching the canal would be reduced

and less water would be lost due to seepage. Reclamation also planned to line the canal immediately downstream from the headworks to eliminate the threat of undue erosion to the bottom or side slopes caused by the turbulence and high velocity of water passing through the gates. It was not easy for Reclamation to make these improvements, because the canal was needed for extended periods of time during the non-irrigating season to fill the Deer Flat Reservoir. The winter months, when the canal could be dewatered, were sometimes not conducive to construction because of freezing weather. Despite these delays, contractors and government forces completed all improvements to the canal by February 1912. The Reclamation Service claimed this Boise Project improvement to be "one of the largest concrete lining jobs in the West" (see HAER photos no. ID-17-A-41, ID-17-A-42).[47]

The Reclamation Service awarded the contract to build the structures along the main canal to Page and Brinton for $48,855. The work included bridges, turnouts, culverts, and the works which diverted water from Indian Creek into the new canal leading to Deer Flat. Unlike its excavating contracts, Page and Brinton had little difficulty completing its contract to build structures along the canal, and at a profit. Reclamation forces built other structures along the canal not included in the Page and Brinton contract. Such structures included a wasteway for discharging water from the canal back into the Boise River about 1-1/2 miles downstream of the headworks, and two drops (drops are structures designed to dissipate the excess energy in water when it descends a steep grade). One drop was located where the New York Canal discharged into Indian Creek; the other was located where the main canal discharged into the Deer Flat Reservoir. Associated with the latter drop was the turnout for the Deer Flat High Line

Canal, which runs above and parallel to the south side of the reservoir. The largest structure by government forces and associated with the main canal built was a concrete-arch bridge carrying the Oregon Short Line Railroad over the canal near Indian Creek.[48]

Design and Construction of the Deer Flat Embankments

The main storage for the project would be at Deer Flat, a natural basin west of Nampa. With the construction of two embankments, the basin could impound a reservoir covering over 9,000 acres. At this early stage of Reclamation Service design experience, the engineers felt comfortable recommending earthfill embankments for Deer Flat because the reservoir would be off-stream and thus not be subject to the current of the river.

In general, a dam is defined as a structure placed in the path of a stream or river, blocking its flow, while an embankment is defined as a structure intended to impound standing water. Earthfill embankments may have three advantages over those built of other materials: 1) they can often be built of locally-available material; 2) under the right conditions, they need not be built on a rock foundation, and can be built on sound earth instead; and 3) their cost is generally competitive with concrete or rockfill. Dam builders in the 19th century were confident using earth for embankments, but believed that more substantial, less erosive materials, such as stone masonry, were required for dams.[49] Among the very first generation of Reclamation projects, those requiring large dams used concrete or masonry, while off-stream reservoirs, such as those at Deer Flat in Idaho, on the Umatilla Project in Oregon, and on the Belle Fourche Project in South Dakota, used earth embankments.[50]

In addition to their location at an off-stream site, the Deer Flat Embankments represented conservative design regarding their height. The first earthfill dam in the United States to exceed 100 feet in height was the San Andreas Dam, completed in 1870. Prior to 1900, American builders constructed only four other dams greater than 100 feet high. With the introduction of mechanized earth-moving equipment in the early 20th century, construction of relatively high earthfill dams became practical. After 1900, the number of earthfill dams exceeding 100 feet in height grew steadily to a peak of 226 built between 1960 and 1970. Noteworthy Reclamation earthfill dams include the Tieton Dam in Washington, which at 232 feet was the world's highest earthfill dam when it was completed in 1925.[51] The Deer Flat Embankments would be quite modest by these standards: 43 feet high for the Lower Embankment, and 68 feet for the Upper Embankment.

There are three basic components to an earthfill dam used for irrigation storage: 1) the earth embankment, 2) a spillway, and 3) outlet works. Important features of the earth embankment are the foundation, cutoffs, the core, upstream and downstream shells, and facing materials. The shells and the core comprise the zones in an earthfill dam. Because shells are not intended to be impermeable, it is usually not essential that they rest on impervious foundation materials. Only topsoil and other unsuitable materials must be stripped prior to placement of the shells. For example, the alluvium of the valley bottom was left in place for the San Andreas Dam. The impervious core, however, must be founded on bedrock or other impervious material. To accomplish this, one or more cutoff trenches are excavated across the bottom of the embankment site and into the abutments. In some cases, the trenches are backfilled with impervious

earthfill, as at the San Andreas Dam. In other cases, concrete cutoff walls are constructed, as at Tieton Dam. Where excavation of the overburden is impractical, interlocking steel sheet piling may be used for cutoff walls.[52]

Many early earthfill dams, such as Tieton, had core walls built of concrete or masonry because those materials were thought to be less prone to erosion. These materials are, however, liable to crack, and thus have passed out of favor. Impervious earthen cores may be comprised of clays or glacial till, and may be placed by hydraulic means or carried into place by vehicles and compacted in layers. Although a homogenous earthen dam may consist entirely of impervious core material, the core is usually adjoined by upstream and downstream shells. In the case of the Deer Flat Embankments, specifications called for each structure to have an upstream impervious zone containing 30% clay, most of the rest of each embankment to consist of compacted earth and gravel, and a downstream shell in each course of gravel. Specifications called for 3 feet of gravel riprap on the upstream face of each embankment.[53]

Earthen dams, whether homogenous or zoned, usually have both upstream and downstream facings to protect the earthfill from erosion caused by weather and the reservoir. Today's design standards suggest that, because the upstream shell of an earthen dam becomes saturated when the reservoir is full, it should be comprised of material which drains freely when the reservoir is drawn down, and it should be of a course grain to avoid liquefaction during an earthquake. Because the downstream shell will never be saturated by water from the reservoir, almost any material may be used which can withstand normal erosion due to weather, such as rock fill, or topsoil and grass. The upstream

face of an earthfill dam must be able to resist the wave action of the reservoir. Usually, rock fill is used for the upstream face; concrete or asphalt have been successfully used in cases where rock is not readily available, but they can be prone to the same problems of cracking as when used for a core wall.[54] Many of these modern standards have gained acceptance since the construction of the Deer Flat Embankments. As originally built, the Deer Flat Embankments did not meet these standards. The gravel upstream face was not sufficient to resist the wave action of the reservoir and once the face was gone, the impervious zone became exposed to erosion in the absence of an upstream shell.

Operators use the outlet works of a storage dam to control the volume of water discharged into the river channel or irrigation canal below the dam. The outlet works generally consist of an intake structure equipped with screens to keep large objects from passing through the outlet; a conduit which carries the water around, beneath, or through the dam; and gates or valves used for controlling the volume of discharge. Outlet works may also include a conduit, called a penstock, which conveys water from the reservoir to a power house where energy embodied in the water is converted to mechanical or electrical energy. A valve is distinguished from a gate by the fact that, in all positions of operation, the valve's moveable member remains in the passage through which water flows. For a gate, the moveable member is withdrawn from the passage in the open position. Without exception, early dams and embankments, such as the Deer Flat Embankments, had the gates for their control works at the upstream end of the conduit because engineers did not want any water under pressure to be within the body of the dam. Placing gates or valves at the downstream end of the conduit would leave water under pressure within the dam when closing the

outlet. The gates used in the outlet works for the Deer Flat Embankments were standard designs already being used on irrigation projects in Idaho and throughout the west.[55]

The design and location of the conduit for the outlet works was also important. Nineteenth-century engineers recommended against placing the conduit within the body of the dam, preferring instead to run the conduit in tunnels around the end of the dam or beneath the foundation of the dam. Nevertheless, 19th-century dam builders did put conduits in dams, believing they could achieve safety by placing the pipes or culverts somewhere near mid-height rather than at the base. This location proved problematic, however, because differential settlement of materials within the body of the dam often caused the conduit to crack, allowing water to leak into the body of the dam, and eventually eroding material along the conduit until the dam failed. By the turn of the 20th century, engineers had learned to place the conduit on a firm foundation, which meant placing the conduit on the dam's foundation along its base. To eliminate a smooth course for water to leak along the exterior of the conduit to the interior of the dam, engineers recommended a series of cutoff walls extending at least 2 feet from the conduit.

For conduits placed at the base of an embankment and with gates at the upstream end, a tower was necessary to connect the gates with the control stand directly overhead and above the water level. Because such a tower would be located directly above the upstream toe of the dam, a bridge would be necessary to provide access to the tower from the crest of the dam. Regardless of where the conduits were located, engineers recommended installing a minimum of two, so that water could be

discharged from the dam even if the gate for one was closed and dewatered for repairs. The outlets at Deer Flat possessed all these characteristics: the conduits were built along the foundation of the embankments, 18-inch-thick concrete cutoffs were built every 20 feet along the length of the conduits, concrete towers for the gates were located above the upstream toe of the embankments, and a bridge linked each tower to the crest.[56]

A spillway is essential for an earthfill dam subject to overtopping of the earth embankment. Uncontrolled overtopping will erode the earth embankment and quickly cause failure of the dam. A spillway must be designed to carry a maximum flood safely. Because the Deer Flat Embankments were designed to impound an off-stream reservoir, because the basin containing the reservoir has virtually no watershed, and because the supply of water to the reservoir is entirely controlled by means of the New York Canal, there is no potential for flood waters flowing into the reservoir and overtopping the embankments. Consequently, Reclamation engineers did not design spillways for the Deer Flat Embankments.[57]

Construction of the Lower Deer Flat Embankment

The contract for the construction of the Lower Deer Flat Embankment went to the firm of Hubbard and Carlson, a Boise company already working on the Minidoka Project. The firm was one of five bidding on the Lower Embankment and had submitted the lowest bid at $256,550.00. D.R. Hubbard and Gus Carlson had formed their company in order to bid on federal irrigation projects in Idaho, and, with his engagement by the Reclamation Service, Hubbard became a tireless promoter of irrigation and

commerce in the Boise Valley, traveling the country trying to draw settlers to the area. He was appointed an appraiser for federal farm loans in 1917.[58]

By March 1906, Hubbard and Carlson assembled construction equipment at the embankment site, six miles from the town of Caldwell on a branch line of the Oregon Shortline Railroad. Bad weather slowed early work. The first task at the site was to dig parallel trenches for the foundation of the embankment (see HAER photo no. ID-17-B-45), but frequent snow and cycles of freezing and thawing interfered with the digging and filling of these trenches. By September 1907, however, earthwork for the structure was in place, most of it having been hauled directly from borrow pits along each side of the embankment. The average length of haul was about 450 feet from either pit. Approximately 586,000 cubic yards of earth were placed by wheeled scrapers, elevating graders, and dump wagons. The contractor generally kept two of the elevating graders in operation loading dump wagons to haul material from the borrow pits to the embankment. When the material was moist and firm, the contractor drew each elevating grader with a 22-horse-power traction engine. When the material was dry and loose, teams of 16 or 18 horses were used. To prepare the ground for excavating, crews first plowed it, a relatively easy process for the top 18 inches of earth. Below that level, however, the dry earth was difficult to loosen because of its clay content, so the contractor turned water onto the borrow prior to plowing. Once loaded, the wagons dumped the material on the embankment where it was spread with horse-drawn graders (see HAER photo no. ID-17-B-51). Four 800-gallon, horse-drawn sprinklers were used to moisten the layers of material on the embankment before compacting (see HAER photos no. ID-17-B-52, ID-17-A-66). Hubbard and Carlson fabricated four concrete

rollers for the compacting (see HAER photo no. ID-17-B-53). The rollers, also horse-drawn, each weighed about five tons.[59]

The upstream zone, comprised of 30% clay, came from the borrow pits along the sides of the dam. Some 85,000 cubic yards of mixed gravel and earth, used especially for the downstream zone of the embankment, came from borrow pits near the north end of the site. Material dug from the north-end pits which was not suitable for the downstream zone was mixed with the earth in the main body of the dam. Because of the greater distance from the north-end borrow pits to the embankment, an average of about 3,600 feet, Hubbard and Carlson used a steam shovel to load the gravel mixture into railroad cars and employed steam locomotives to pull the cars and place the material on the embankment (see HAER photo no. ID-17-B-47, ID-17-A-48). After a train of cars dumped a load of gravel on the embankment, teams of horses moved the tracks about 10 feet to one side or the other (see HAER photo no. ID-17-B-64). The 8-inch lifts from the north-end pits were sprinkled and rolled just like the material from the borrow pits along the sides. After the body of the embankment was completed, the contractor applied an additional 255,000 cubic yards of gravel from the north-end pits over the top as a facing. Crews did not sprinkle or compact the facing. The gravel facing of the embankment was nearly completed by December 1907 and concrete work was completed in January 1908. For the contract, Hubbard and Carlson used equipment valued at $50,000, including:[60]

1	Vulcan 60-ton steam shovel	5	tongue scrapers
2	steam locomotives	9	slip scrapers
32	dump cars (railroad)	17	wheel scrapers
1.5	miles of steel rail and switches	4	sprinkling wagons
4	elevating graders	2	concrete rollers
2	road graders	4	small gasoline engines

48	dump wagons	3	centrifugal pumps
2	traction engines	15	plows
16	fresno scrapers	1	derrick

During the course of the contract, Hubbard handled the finances and administrative tasks while Carlson supervised the construction. Most of the workers the contractor hired were from the Boise Valley, especially ranchers who were hired with their teams. According to a Reclamation report, the type of work done with teams and the construction machinery "required the services of labor above the average in skill and intelligence," which was scarce during most of the construction period. As a consequence, Hubbard and Carlson paid relatively high wages and worked their men 10-hour days. Skilled workers and their wages included: timekeeper and bookkeeper, $110 per month; general foreman, $100 per month; steam-shovel runner, $150 per month; steam-shovel cranesman, $115 per month; steam-shovel fireman, locomotive engineer, and traction-engine foreman, $100 per month; boiler maker, when employed for repairs, $6.75 per hour. Other laborers and their wages included: engineer of traction engine, $4.75; blacksmith, $3.25 per hour; elevator men in charge of grader and blacksmith's helper, $2.70 per hour; track foremen and drivers of 6- and 8-horse teams, $2.50; steam-shovel pitmen, locomotive brakemen, trackmen, drivers of 2- and 4-horse teams, plow holders and helpers, and scraper holders, $2.25. The contractor employed an average of 55 men during the course of the contract. While incurring costs of $223,938, the contractor received payments from Reclamation of $269,931, yielding a profit of $45,993, or just over 20%. [61]

In the midst of early Deer Flat construction, Reclamation's special agent A.R. Greene made allegations of collusion between Reclamation supervising engineer D.W. Ross and several Deer Flat

contractors, including Hubbard and Carlson. In March 1907, Greene claimed that Ross had received 12,000 acres of land in exchange for favors granted the contractors. Ross responded that animosity on the part of contractors to whom he had denied extensions or adjustments of contracts had given rise to rumors on this count, but that none were true. This favorable interpretation was seconded by the Director of the Reclamation Service, F.H. Newell, and Secretary of the Interior James Garfield. According to press accounts, Monarch and Porter, Page and Brinton, and the Utah Fire Proofing Company, all contractors on other portions of the Boise Project, were accused of trying to "intimidate the engineers and to coerce them into taking a less positive position in protecting government interests." On April 13, 1907, Secretary Garfield cleared Ross of all charges, subsequently raising his salary as well.[62]

In 1908, Hubbard and Carlson asked for an extension of 59 days on their contract regarding the first 35% of the project. In addition to adverse weather conditions, they cited an unpredicted increase in the amount of earthfill needed for the dam, congestion of freight traffic, "unusual stringency of the labor market," the fact that many of the horses working on the project had fallen ill, and the fact that some of their equipment was unexpectedly called to the Minidoka Project. Ross objected to the request, claiming that conditions were not as bad as the contractor stated. Nonetheless, the Reclamation Service granted the extension. The Lower Embankment was ultimately completed ahead of schedule for $284,301, almost $9,000 less than the original estimate.[63]

Construction of the Upper Deer Flat Embankment

When the Reclamation Service received bids for the Upper Deer Flat Embankment, "Section 5" of Specifications 68, the low bid of $382,150 was submitted by P. McDonnell of Duluth, Minnesota. Hubbard and Carlson's bid was slightly higher at $389,950, more than $130,000 greater than the firm's bid for the Lower Embankment, despite the fact that the volume of earth to be moved for the two embankments was estimated to be nearly identical (the Lower Embankment would require 950,000 cubic yards of material, the Upper Embankment would require 1,000,000 cubic yards). Hubbard explained that his firm's bid for the Upper Embankment was proportionally much higher because of the greater distance from the borrow pits to the embankment and the nature of the materials to be moved. The Upper Embankment would be almost exclusively a steam shovel operation, and thus required a much higher equipment cost. The Reclamation Service considered all three bidders' proposals for the Upper Embankment to be too high, and decided instead to accomplish the work under force account.[64]

The concept of the force account was new and somewhat controversial for the Reclamation Service at the time of the Boise Project. In 1905, F.H. Newell, then Chief Engineer, advised George Wisner, a consulting engineer, that Reclamation did not have official or legal means to pay labor on force accounts. Wisner responded that force accounts should be formally instituted: he saw them as guaranteed to save the Government money "because no [private] contractor can afford to undertake such work, except with the expectation of making a fair profit." In April 1906, Newell undertook an investigation of how larger railroads approached the force account issue, and

discovered through his survey that most relied on force accounts for construction jobs that were especially difficult or unpredictable. Later that year Congress approved the practice for the Reclamation Service, and the Director of the Reclamation Service wrote a memo to the Secretary of the Interior detailing the benefits of force account work, including the prevention of collusion by private bidders. The memo concluded that "there is no question but that the Government has been and is receiving better offers on reclamation work than would have been the case if it had been compelled to accept the bids received on large contracts." In addition, the force account system brought about particularly careful cost-keeping of both government and contractor work so that "at all times a comparison could be made of the relative economics of each system of work."[65]

Estimates for the construction of the Upper Deer Flat Embankment, still to contain 1 million cubic yards of earth and gravel fill, were set at about $270,000, a substantial savings over the lowest private bid for the work. The project could not begin right away because steam shovels had to be ordered. Reclamation engineers considered buying used equipment, for faster delivery, but discarded the idea in favor of two new 70-ton steam shovels, purchased for $8,750.00 each from the Atlantic Equipment Company in New York City. Other equipment used for the placement and compacting of fill in the embankment included:

4	railroad locomotives	1	steam pump
60	dump cars (railroad)	1	concrete mixer
2	road machines	2	concrete rollers
5	sprinkling wagons		

To operate the locomotives and dump cars, Reclamation used 427,000 pounds of steel rail.[66]

To haul material to the embankment, steam shovels at borrow pits at either end of the site loaded the 4-yard dump cars. The two borrow pits at the east end of the dam were about 2,000 feet long, with extreme hauls to the embankment itself of 2,700 and 3,900 feet respectively. The borrow pits at the west end of the embankment were about 1,500 feet long, with extreme hauls of 2,650 and 3,300 feet. Once loaded, 12-ton locomotives pulled the dump cars in trains of twelve along 36-inch-gauge track laid atop the growing embankment. After a string of cars had dumped its loads on the embankment, teams of horses pulled the track sideways across the structure so that cars could dump fill at an adjacent location. Teams moved the track an average distance of 14 feet after each dump. Repeating the technique, crews distributed material so evenly across the length and width of the structure that only two road machines were needed to complete the spreading. The fill was sprinkled and compacted in a manner similar to that used at the Lower Embankment.[67]

Sprinkling carts used on the Upper Embankment had a capacity of 600 gallons. Water for the operation was taken from the nearby Ridenbaugh irrigation ditch and stored in a 25,000 gallon reservoir, but a well was also sunk in case flow from the canal failed, as it sometimes did in winter. Water from the ditch or well was pumped into two elevated 20,000-gallon tanks, which in turn supplied hydrants placed every 100 feet along the embankment. In mid-1907, Reclamation replaced some of the teams of horses with a traction engine to draw a roller used to compact material on the embankment. Reclamation hired twelve heavy wagons, two plows, and twenty teams of horses to perform miscellaneous work around the site.[68]

In addition to its own engineers and office staff, the Reclamation Service had to hire a variety of other people to fill the several job classifications on its construction force. Skilled positions included: master mechanic, paid $200 per month; blacksmith, paid $100 per month; steam shovel runner, paid $150 per month, and steam shovel cranesman, paid $110 per month; locomotive runner, paid $110 per month; traction engine runner, paid $100 per month; night hostler for locomotives, paid $90 per month; four-horse teamsters, paid $67.50 per month, and two-horse teamsters, paid $62.50 per month; and stableman, paid $75 per month. Laborers included: track foremen and carpenters, paid $3.00 per day; blacksmith helper, paid $2.50 per day; pitmen, brakemen, and general laborers, paid $2.25 per day; and water boy, paid $1.50. These rates of pay were comparable to those being paid by contractors working on the project. Whenever possible, Reclamation hired laborers who had homesteads on the project, but because government crews worked eight-hour days at a time when there was ten-hour-per-day work available in the area, such laborers were scarce. Thus, job openings for government laborers attracted some families from outside the area who moved into tents or temporary houses during the construction project. Reclamation employed an engineering and clerical staff of six persons during construction of the Upper Embankment.[69]

The Government built a camp in July 1906 to house workers and activities supporting its construction effort. The camp consisted of 16 buildings, including a mess house, bunk house for the cooks and office staff, laborers' bunkhouse, mechanics' bunkhouse, teamsters' bunkhouse, reading room, stables, granary, storehouse, pumphouse, shops, engineers' quarters, and the office. The combined capacity of the bunkhouses was 120 men, and the mess house could serve as many. Reclamation charged workers

$5.25 per week for board at the mess house. The stables accommodated 60 horses, which were supplied under contract by W.H. Williamson at $20 per animal per month.[70]

In June 1907, D.W. Ross informed the Director of the Reclamation Service that, although a double shift of steam shovel operation had been started at the Upper Embankment on May 6, and that the "Crews are all conscientious and anxious to make a good record," the "output is not satisfactory." He asked that Reclamation authorize the purchase of an additional steam shovel, but was told that "in view of the present state of the reclamation fund, it is absolutely out of the question." Shortly thereafter, the steam shovel crews demanded increased wages. Ross came up with a plan to accommodate their demands without, apparently, costing the Reclamation Service any additional money in the long run. He instituted an incentive system whereby he paid a bonus of 3-3/4 cents to hauling crews for every cubic yard of fill over 22,000 they hauled in a given month. Each crew, consisting of a steam shovel runner, cranesman, fireman, two locomotive engineers and a foreman in charge of the track, divided the bonus among themselves. According to Ross, because the team as a unit was responsible for earning the bonus, a high output would be maintained through peer pressure: "One drone or careless workman could easily cut down the output. The others would, of course, not stand for this."[71]

Reclamation first turned water into the Deer Flat Reservoir in March 1909. The lowest point of the reservoir is immediately behind the Upper Embankment, so the first large amounts of water accumulated there. When the water reached 20 feet in depth in April, moist spots appeared on the flats immediately downstream from the embankment. These spots increased in size and number,

some eventually growing into bubbling springs, and an 8-inch tile drain laid under the downstream toe of the dam was soon discharging water at full capacity. Engineers believed that the seepage was coming from the entire reservoir bottom, although examination of the reservoir bottom and the embankment itself revealed no well-defined leaks.[72]

The seepage worsened steadily from week to week. In May, consulting engineer D.C. Henny, believing the seepage to be carrying up fine sand from within the dam, suggested the construction of a trench parallel to the dam about three feet below the saturated surface of the flats downstream from the dam. Henny intended to then blanket the flats with a heavy layer of gravel--from three to fifteen feet deep, 200 to 350 feet wide, and 1200 feet long--interlaid with a complex drain system. Director A.P. Davis thought this plan was too expensive for the existing conditions, and recommended simply dumping fine material from barges into the lake to be carried by currents into leaks, thus plugging them. [73]

Henny's plan was chosen, but it became apparent after a portion of the trench was built that the springs were not originating underneath the dam, but in the top soil downstream from it. Henny's trench was abandoned in favor of a row of wooden sheet piling along the downstream toe of the dam. This piling, with the gravel blanket and drains previously planned, was deemed sufficient to put the dam, and the lands below it, in safe and stable condition. The new material would provide loading to the foundation and counter uplift pressure. The equipment and personnel employed on the embankment performed this work as well, tracks being hauled sideways onto the gravel blanket in a manner similar to that used in building the

embankment. Reclamation leased a 2,200-pound hammer pile driver to drive 2-by-12 inch, triple-thick planks into the ground along a 1,323-foot line. This work started in May 1909 and was finished the following August at a total cost of $21,149.12.[74]

Learning that the seepage was passing through top soil, rather than sand, Henny determined that the material in the embankment was not threatened, "thus depriving the phenomenon of its importance." Henny concluded that the Upper Embankment was not endangered, and that the Lower Embankment would also prove tight. He wrote to the Reclamation Service Director that study of the borrow pits indicated that the materials in the Upper Embankment appeared to be much more open than those in the Lower Embankment, but leakage in any case was not serious.[75]

Construction of Laterals to Complete the Boise Project

As part of the Boise Project, laterals were planned to deliver water to within one-half mile of each farm unit, but as portions of the main canal reached completion in 1908, the Reclamation Service realized that it would not have funds to build laterals and thus bring homesteaders' lands under cultivation. Without irrigation, the homesteaders could not begin repayments of construction costs. A solution seemed to lie in employing settlers--many of whom had no other source of income at the time--to build the ditches, paying the settlers in certificates that could be used to repay construction charges once water was actually delivered to the land. The Payette-Boise Water Users Association would issue certificates, and all work would be contracted to settlers through competitive bidding, and

then supervised by Reclamation engineers. Theodore Roosevelt's Secretary of the Interior, James Garfield, approved the plan on February 21, 1908.[76]

By the end of 1908, contracts had been let for $292,000 worth of cooperative work on the laterals, representing completion of 35% of the excavation for distributing canals and laterals. Participants included individual farmers, local companies, and even the state penitentiary. Although it looked at that point like 50% of all excavation would be done by April 1909, 50% of the project lands could not yet be irrigated. Settlers preferred to work near their homes, so the laterals were being excavated piecemeal. This meant that some completed lengths of ditch were not yet connected to a completed system of laterals.[77]

By the end of August 1910, the completed distribution system on the Payette-Boise Project was taking shape, but far from complete. Canals and laterals leading from the Main Canal (the official name of the reworked New York Canal in the early years of the Boise Project) were to serve over 100,000 acres, but were only about 42% were finished. Canals leading from the outlet works through the Deer Flat Embankments were to serve another 90,000 acres, but were only 47% complete. The Reclamation Service pressed ahead with its cooperative agreements so that by the end of 1912, the distribution system was virtually complete, with some of the work performed through cooperative contracts with farmers and some through small contracts with conventional contractors. All of the control structures in the distribution system, such as turnouts and drops, were placed by force account.[78]

Above Indian Creek, numerous laterals turn water directly out of the Main Canal. Important canals of the distribution system include two emanating from the Main Canal: the Mora Canal, with headworks where the old New York Canal segment empties into Indian Creek; and the Deer Flat High Line Canal, with headworks at the lower end of the Main Canal just above the inlet structure to the Deer Flat Reservoir. At the time it was built, the Mora Canal, which runs south and west of Deer Flat, served the highest ground on the Payette-Boise Project. The Deer Flat High Line Canal runs parallel to the Mora Canal and serves lands at elevations between the reservoir and those served by the Mora Canal.

Originally there were three canals leading from the Deer Flat Embankments, two from the Upper Embankment and one from the Lower. The smaller of the canals heading at the Upper Embankment, the Deer Flat Nampa Canal, serves lands west of Nampa, while the larger, the Deer Flat Caldwell Canal, serves lands in the Pioneer Irrigation District east of Caldwell. The original canal leading from the Lower Embankment, the Deer Flat Low Line Canal, serves land south and west of Caldwell.[79] An additional canal, the Deer Flat North Canal, was built in the 1910s, with headworks at the Forest Embankment, to serve additional lands south of Caldwell. The headworks are now at the north end of the Lower Embankment.

Improvements to Deer Flat Embankments in the Early 1910s

Reclamation forces finished placing the gravel facing on the Upper Embankment in the spring of 1911. Crews then moved one of the steam shovels, three of the locomotives, and a number of the dump cars to a low-lying site about a mile east-northeast of the

Lower Embankment to build a third embankment called the Forest Embankment, sometimes called the Middle Embankment. (No explicit reason for construction of the Forest Embankment was found). Presumably, it was to separate the low-lying area from the reservoir so that it would not fluctuate between marsh and dry conditions as levels in the reservoir changed.) After digging a cut-off trench, the crews built an earthfill embankment 16 feet high, 950 feet long, and comprised of 22,500 cubic yards of material. Most of the material came from a borrow pit near the east end of the Forest Embankment, while the gravel facing came from one of the borrow pits at the north end of the Lower Embankment. Average haul from the borrow pit near the Forest Embankment was about a quarter of a mile and the average haul from the Lower Embankment pit was a mile and a quarter. Once in place, the material was wetted by sprinkling water pumped through a hose from the water's edge of the reservoir. As with the two larger embankments, Reclamation used a concrete roller to compact the material.[80]

Erosion of the upstream sides of both the Lower and Upper Deer Flat Embankments by wave action was an ongoing problem from the first filling of the reservoir. Reclamation forces had reinforced the embankments in 1910 by adding upstream gravel facings. Reclamation made further improvements to the Lower Embankment during the construction of the Forest Embankment. Crews laid tracks for trains of dump cars to both the Forest and the Lower Embankments from the gravel pits at the north end of the Lower Embankment. Reclamation forces dumped material at the Lower Embankment in such a way as to widen the crest from 20 feet to more than twice that and to create a slope of 1-1/2:1 meeting the toe of the original 3:1 slope of the embankment. This alteration required 226,000 cubic yards of gravel. With the

equipment remaining at the Upper Embankment, crews placed gravel on that structure to similarly widen and armor it. In addition to the set of tracks laid along the top of the structure, Reclamation placed another set along the upstream face 27 feet below the crest. Bad weather slowed the procedure and increased expense for hauling coal and supplies to the site over bad roads. Reclamation spent $22,326 to improve the Upper Embankment.[81]

The gravel deposited on the Upper Embankment was expected, like that at the Lower Embankment, to naturally assume a slope of 1-1/2:1, carrying finer material to the bottom of the structure and leaving larger material to protect the dam against wave action. Reclamation engineers acknowledged at the time of construction that such facing would not be "adequate for all time to come," and for this reason kept the equipment used to construct the facings in storage near the Upper Embankment. A recent assessment of the 1911 anti-erosion operation notes that the approach seems to have been trial and error, and largely unsuccessful: wave action quickly eroded the facings, making further improvements necessary in the following decades.[82]

Improvements to the Deer Flat Embankments by the Civilian Conservation Corps

In 1935, the Bureau of Reclamation determined that waves and ice had so badly damaged the Deer Flat Embankments, reducing the maximum width of the Lower Embankment from 36 to 25 feet, that substantial restoration work was needed (see HAER photo no. ID-17-B-73). Reclamation estimated that some 14,000 cubic yards of gravel and 21,000 cubic yards of rip-rap would be needed to restore and then protect the upstream face of each of the two main embankments. This work was assigned to the Civilian

Conservation Corps (CCC), which established a camp near the Lower Deer Flat Embankment in September 1936 and another camp soon thereafter near Boise. The CCC housed young men (or "boys," as they were called by CCC supervisors) at these camps in facilities based on the model of the military barracks. The camp near the Lower Embankment was identified as BR-24 and housed CCC Company 2506. That near Boise was BR-73 (also known as Camp Meridian) and housed Company 3279. CCC crews from the two camps worked under the direction of Bureau of Reclamation personnel in the area for the next seven years.[83]

BR-24 held between 170 and 223 enrollees at any given time between its opening in 1936 and its closure in 1943. The CCC intended the camp to be a "home away from home" where underprivileged young men could be afforded educational as well as work opportunities. In addition to eight large barracks, a mess hall, infirmary, and mechanical buildings, the camp contained educational facilities in which evening classes were held in such subjects as reading, writing, arithmetic, social ethics, typing, and first aid. Class attendance was compulsory, and enrollees--mostly teenagers from Kentucky and Tennessee--were encouraged to take additional correspondence courses through the Works Progress Administration (WPA). Daily on-the-job training in mechanical and engineering skills was also provided. Enrollees operated a bakery, garden, and movie theater at the camp, and their activities and performance in work and leisure were closely monitored by CCC administrators. Detailed weekly reports on safety and cleanliness and on work accomplished were issued by the CCC. Camp BR-73 maintained many similar facilities. Both camps were reported by CCC inspectors to suffer

from occasional "low morale" and poor management, attributed at BR-24 to the fact that its supervisor was quite elderly and untrained in administrative matters.[84]

Though the CCC forces performed a variety of tasks for the Bureau of Reclamation at Deer Flat, including the eradication of rodents and weeds, maintenance of Reclamation phone lines, forest fire prevention, and the planting of trees for fence posts, the majority of their work was heavy manual labor for the repair and maintenance of embankments, canals, and laterals. The work on the Lower Embankment began with the preparation of a 6-foot-wide, 6-foot-deep ditch across the downstream toe of the embankment. This ditch was dug by Camp BR-24 enrollees, then filled with large rocks hauled from a quarry three miles away. Other large-scale tasks performed by CCC enrollees involved the repair of the embankment face itself. Lava rock was blasted at a pit four miles from the embankment and broken with jack-hammers. Crews then used a drag-line to load the rock onto the camp's 12 trucks, which brought the rock to the embankment where 100 men unloaded and distributed the material. Once the body of the embankment had been built up to the desired level, CCC crews placed the large, irregularly shaped boulders to form a protective rip-rap on the upstream face. After completing work on the Lower Embankment in 1937, they began similar improvements on the Upper Embankment. By January 1939, the CCC forces had placed 26,100 cubic yards of rock and 17,000 cubic yards of gravel on the Lower Embankment and 21,200 cubic yards of rock and 14,300 of gravel on the Upper Embankment.[85] The CCC crews used larger riprap for the upstream face of the Upper Embankment. That, in conjunction with less severe wave action on the Upper Embankment, apparently explains why its upstream face has survived much better than that of the Lower Embankment.

CCC work continued into the early 1940s. During the CCC engagement at Deer Flat, crews completed other tasks, including: construction of stone parapets and other decorative stonework along the crest of the Upper and Lower Embankments; building a rock retaining wall along both sides of the county road where it crosses the Nampa-Deer Flat outlet; manufacture and placement of concrete piping in many laterals in the area; and participation in the lining of the New York Canal with concrete. In all cases, the Bureau of Reclamation provided supplies and supervision, while the CCC paid for operation and depreciation of equipment and salaries of CCC personnel. Work orders and reports consistently show that Reclamation was pleased with the CCC's work.[86]

Camp BR-73 closed in 1941 and was placed under the care of the Army. Camp BR-24 closed in 1943, but its disposal created a controversy. The Boise Project Board of Control wished to dispose of the buildings by turning them over to the Farm Security Administration (FSA) for the housing of transient farm laborers, primarily for working in the sugar-beet fields. There was anxiety on the part of the Board of Control and Reclamation personnel, however, when the FSA suggested that Mexican and Japanese workers might be housed there, presenting, it was thought, a security risk to the damsite. Similarly, a plan by the FSA to house high-school boys at the site was rejected because "while the boys probably would not cause any damage to the dam, the fact that they would be located there and flocking over the end of the dam would make effective guarding impossible." Correspondence dating from late 1943 shows the Army's wish to occupy the camp with men who "will be in charge of

three bombing areas in the general locality of the Deer Flat Reservoir." The final disposition of the camp is not recorded.[87] The camp is no longer extant.

DEVELOPMENT OF THE BOISE PROJECT

Settlement on the Boise Project

The circumstances under which settlement occurred on the Boise Project seem to have been controlled by a combination of local interests, most often represented by the Payette-Boise Water User's Association (whose directors included businessmen and bankers) and engineers and directors of the Reclamation Service. These two groups were generally in agreement, and frequently united against the sentiments of some farmers and landowners. During the time of the project's construction, Reclamation and the Water User's Association developed complex series of regulations regarding the purchase of rights-of-way, the allocation of responsibility for various aspects of the project, and the subdivision of public lands. The record of almost constant controversy during the early years of the Payette-Boise Project suggests that the regulations did not enjoy unanimous support among farmers and landowners.

One of the earliest and most heated debates arose over the Government's purchase of lands for the site of the future Deer Flat reservoir, roughly 7,000 acres divided among 30 or 40 tracts. J.H. Lowell, president of the Payette-Boise Water Users Association, started securing contracts for the purchase of the lands in April 1905.[88] Reclamation's D.W. Ross, who was closely involved in determining the price of purchase, decided by May 1905 that landowners would receive between $12 and $15 per acre for unimproved land. Ross believed these figures to be "extremely liberal" and likely to save the Government "$100,000

in right-of-way alone." The Nampa, Boise, and Caldwell Chambers of Commerce all gave their approval to this judgment. Ross designated higher amounts up to about $30 per acre for improved lands.[89]

His suggestion that some of the local landowners asked to sell at these rates might be "pretty sore" proved to be an understatement. Many landowners at Deer Flat felt that they were being denied fair profits by the Government. They claimed that they could not possibly replace their holdings anywhere else on the Boise Project for the amounts offered, and that if the Government had not intervened, their lands would have ultimately been irrigated by private projects and attained higher values. Further, they felt that their lands were being taken in an effort to improve lands around the reservoir, which would then increase in value, but that their own land would "receive no benefit."[90]

Ross countered with the argument that the Ridenbaugh Canal and other existing private irrigation works near Deer Flat would never have sufficient water for all lands in the basin, thus undermining the landowners' argument that their land would have increased in value without the Government's arrival. Speaking on behalf of the Payette-Boise Water Users Association, Lowell offered the somewhat circular argument that there was no way the Government itself could have ever chosen to improve the land now designated for the reservoir because "the (Boise) project itself depends upon the building of a reservoir which would necessarily include these lands." Other advocates of Reclamation's pricing scheme pointed out that there were many abandoned farms at Deer Flat, and that landowners had very possibly inflated their prices upon learning that the Government planned to purchase the land.[91]

Some Deer Flat property-owners did sell their lands to the Government without argument; by March 1906, the Reclamation Service had entered into 27 contracts with landowners. But in April, an engineer from outside the Boise Project was sent to assess the situation. He found that several of the landowners were newcomers to the area, and had only paid about $10 an acre for their lands, both facts suggesting that they were speculators looking to profit from the Government's need to buy Deer Flat land. Claims involving 246 acres eventually went to court as condemnation cases. The landowners objected that the Government was acting to deprive some citizens of profits in order to increase profits to another group. The district court judge found that under the terms of the Reclamation Act the Government had the authority to purchase private lands for the improvement of public lands.[92]

Reclamation Service counsel B.E. Stoutemyer reported that during the trial, defendants became "pretty badly scared about their cases and began making offers of compromise." The lands in question were finally purchased under a court settlement for $20 an acre, a rate actually lower than the initial government offer the previous September. It is difficult to assess the fairness of this judgment, but it might be noticed that at one point in the process of buying rights-of-way for the reservoir, Ross publicly threatened to suspend the Reclamation Service survey of Deer Flat if the land was not sold, a gesture at least one local resident saw as coercive.[93]

Another controversy that simmered through the construction period for the Deer Flat Embankments was the designation of Reclamation Fund money for works on the south side of the Boise River, but not the north, as originally planned. As work on the

Boise Project progressed, residents of lands north of the river became concerned over their chances for receiving water under federal auspices. In January 1908, they founded the Northside Payette-Boise Water Users Association, made up of seven districts. This group, under the leadership of Walter Cupp, claimed that it did not stand in opposition to the southside development. Nonetheless, a few days after the new association was formed, Ross wrote to the Director of the Reclamation Service that he (Ross) was eager to "prevent what might easily become a divided support...It could be done without friction at this time if the wind were quietly taken out of Mr. Cupp's sails." Director Newell agreed that Mr. Cupp and the other northsiders should take up their complaints with the existing Payette-Boise Water Users Association.[94]

Many northside homesteaders sent pleas to the Department of the Interior describing the hardships of life without irrigation water. One wrote that "it is a pitiful sight to see little hungry children and sad-faced mothers waiting for water...is there no hope of water on the north side?" At the same time, other northside residents began to plan for the possibility of private development of the region. In fact, records suggest that Reclamation intentionally delayed notifying the northsiders of its cancellation of that portion of the project to encourage the formation of a private irrigation system there. This was probably done to minimize ill-will against the Government and to assure that some irrigation would come to the waiting northsiders. The Governor of Idaho notified the Federal Government that "though we appreciate what the federal government has already done in Idaho...it is our belief that from this time on the state will be able to bring under cultivation and irrigation all of the available arid land under the Carey Act

law." The press thought this was going too far--Carey Act projects were usually quicker to execute, but much more expensive to users than federal reclamation projects. Nonetheless, private development continued, with federal activity on the northside withheld until the 1920s.[95]

By 1908, homesteaders had filed on all but 94,000 of the approximately 300,000 acres available under the Boise Project. How the remaining lands should be divided was debated among Reclamation Service administrators, depending on their vision of how best to achieve successful settlement of the area. Arguments for smaller, 40-acre farm units, put forth by F.H. Newell, asserted that there was more danger of farm failure if families had too much land to manage and too great an annual construction cost to repay than if they had too little. The original plan for the project called for 40-acre claims because the tendency in the Boise Valley for irrigated lands up until that time had been for small, more intensively cultivated farms. But an inspection of the region sponsored by the Reclamation Service resulted in the determination that 80-acre farm units be instituted because the area was simply not ready for the intensive farming that could yield a livelihood for a family on 40 acres. Grain and forage crops, which required larger tracts than did fruit and vegetables, were deemed to be preferable crops for new homesteaders until shipping facilities to distant markets developed. The inspectors felt that a subdivision of project lands would come about as marketing circumstances improved in the valley. The Payette-Boise Water Users Association also supported 80-acre farm units.[96]

The ability of water users to repay construction charges on their lands was of vital importance to the Reclamation Service, probably because Congressional favor depended on reliable replenishment of the Reclamation Fund. This concern had contributed to the development of the cooperative-work-agreements scheme with local farmers to complete the system of laterals. Money earned building laterals allowed land owners within the project to afford to begin making payments into the Reclamation Fund and to begin to irrigate their crops. A significant difficulty with the cooperative scheme emerged, however, when Secretary of the Interior Garfield was replaced by Richard Ballinger, who interpreted the Reclamation's cooperative certificates as a type of negotiable security. Because government agencies were prohibited from going into debt in this manner, Ballinger suggested the cooperative certificates were illegal. While Ballinger had the Attorney General officially challenge the legality of the cooperative scheme, he curtailed its progress. Congress then authorized a $20-million loan to the Reclamation Fund in 1911, so work on the Boise Project distribution system continued to completion.[97]

The employment of local residents on the Boise Project remained an issue after the cooperative scheme ended. In 1911, a labor union member accused the Reclamation Service of hiring "aliens from Southern Europe" while U.S. citizens in Idaho went without work. The Department of the Interior dismissed the complainant as a "labor agitator," but interestingly, then conducted an elaborate survey of the Boise Project storage and distribution units to determine which percentage of its employees were indeed "foreigners." The Department of the Interior also issued instructions to project engineers to hire settlers on the Boise Project whenever possible, followed in priority by settlers

on the Minidoka Project who were seeking employment, and then "white-men--so-called," and finally "foreigners--so-called." The Reclamation Service claimed to employ foreign labor only when no American workers could be found. To the inquiries of the Idaho Secretary of State in 1915 about the employment of Idaho residents, the Secretary of the Interior explained that to prohibit the hiring of foreign labor outright would bring about cost increases in constructing the Boise Project, and thus higher construction charges to the farmers who ultimately had to pay for the project.[98]

Development of the Boise Project had a more significant impact on economic development in the Boise Valley, however, than simply providing jobs on construction projects. When Reclamation surveyed the development of towns in the vicinity of Deer Flat in 1916, it is not surprising, considering the agency's interests, that the surveyors found "a material advancement of prosperity." The annual report for the Boise Project in 1916 stated that while populations of project towns--which included Kuna, Nampa, Boise, Caldwell, Wilder, and Meridian--were stable, the percentage of farmers in the area had increased from 4% to 14% in the previous year. The increase was due, however, more to births in existing families than to new settlers moving into the area. Of greater significance was the fact that the business districts of several towns were growing as roads and railroad transportation improved, with sizable milling facilities and grain elevators appearing in Caldwell and Nampa. A facility for the production of crop sprays opened in Meridian. Organizations and clubs were burgeoning. Among them were numerous cooperative associations, such as the Nampa Cooperative Creamery and the Caldwell Potato Growers' Association, and community groups such as the Parent Teachers Association of Meridian. Still sensitive to the question of the

place of birth of people living within the boundaries of the project, the report noted that a majority of farmers were native-born rather than foreign-born. Interestingly, the author of the report expressed an expectation that those farmers of German ancestry might prove to be of greater competency than others because "they seem to apply a natural thrift and leaning toward intensive cultivation to their farm operations."[99]

Creation of the Deer Flat National Bird Reservation

Beginning in 1903, the United States established bird reservations under an Executive Order. From the inception of the reservoir at Deer Flat, it was envisioned as a refuge for wildlife as well as a recreational facility offering public boating, swimming, and fishing. On February 25, 1909, an Executive Order created 17 bird refuges on federal Reclamation projects, including the Deer Flat National Bird Reservation on the Payette-Boise Project. The Biological Survey of the U.S. Department of Agriculture, which in the 1930s was transferred to the Department of the Interior to become the U.S. Fish and Wildlife Service, managed the federal bird refuges. Because most of the land around the Deer Flat Reservoir was already in private hands, the refuge consisted of only a thin strip of land around the lake, comprising one of the smallest national bird reservations on a federal Reclamation project. After the Reclamation Service began filling the reservoir in the summer of 1910, large numbers of waterfowl, including blue herons, ducks, geese, and swans appeared. By the spring of 1911, the Biological Survey estimated that ducks, coots, and grebes had established as many as 200 nests along the shore. Other species which began

nesting on the refuge included the killdeer plover, spotted sandpiper, Wilson snipe, California gull, Forster's tern, avocet, and black-crowned heron.[100]

Because of the proximity of Deer Flat to Nampa, Caldwell, and Boise, the Biological Survey recognized an opportunity to test the viability of a refuge which would also be heavily used for recreational purposes during summer months. The Caldwell Traction Company began operating interurbans from Caldwell to the reservoir in 1911 and placed launches and rowboats on the lake in 1912. In cooperation with the Reclamation Service, the Biological Survey placed restrictions on recreational use of the reservoir to assure that nesting birds would not be disturbed. All boaters were required to purchase permits, and regulations stipulated that no firearms could be carried in the area.[101]

Construction of Arrowrock Dam

The major improvement made on the Payette-Boise Project in the early 1910s was the construction of another major storage facility, Arrowrock Dam at the juncture of the Boise River's main channel and south fork. A concrete gravity-arch structure, Arrowrock Dam was built to a height of 354 feet to impound a reservoir of 286,000 acre-feet, half again as great as the capacity of Deer Flat and therefore significantly increasing the acreage which could be irrigated on the Payette-Boise Project. When completed in 1915, Arrowrock was the highest dam in the world. Construction of Arrowrock, which began in 1912, precipitated several other important changes to the project as well. To transport materials from Boise to the construction site, Reclamation built its own railroad along the Boise River in 1911. To house the growing administrative and engineering staffs

for its Idaho operations, Reclamation also built its own headquarters building in 1912 on the west side of Boise near the tracks leading to Arrowrock Dam.[102]

The most prominent change to existing features of the Payette-Boise Project brought about by the construction of Arrowrock Dam was the conversion of the Boise River Diversion Dam to a hydroelectric generating facility to supply the Arrowrock construction project with electrical power. The powerhouse for the generating equipment was built of reinforced, cast-in-place concrete between the logway and the headworks for the New York Canal (see HAER photos no. ID-17-A-37, ID-17-A-38). Equipment included three vertical-shaft turbine-generator units. Each turbine had a twin set of runners providing a capacity of 725 horsepower at 180 r.p.m., and each generator was rated at 500 kilowatts delivered at 2,300 volts of alternating current. Air-cooled transformers converted that current to 22,000 volts for transmission to Arrowrock. The electrical system at the powerhouse was also connected to the grid of the Idaho-Oregon Power Company. To accommodate the powerhouse, one additional tunnel was added to the two sluice tunnels already in place so that each turbine-generator unit would have its own tailrace tunnel.[103]

In 1913, shortly after the completion of the powerhouse, another important change took place at the Diversion Dam: Reclamation installed a rolling dam as a gate on the logway. After trying without success to design a gate for the particular application at the Diversion Dam, Reclamation engineers decided to use a design patented by Maschinen-Fabrik Augsburg-Nurnberg, A.G., of Germany. The rolling dam consists of a steel cylinder with gears at each end which engage sprockets along inclined

racks in the abutments. When lifted by the chain connected to an overhead hoist, the gears turn in the sprockets, causing the cylinder to rotate as it rises. Such a design allows water to flow over the rolling dam when in the closed position, and allows sufficient vertical clearance for logs to pass when the rolling dam is raised to an open position. At the time the rolling dam was installed at the Diversion Dam, the design was already being widely used in Europe, especially in Germany, but only 13 were in place or being installed in the United States. Of those, the one on the Diversion Dam was by far the smallest at 30 feet in length.[104] The Boise River Diversion Dam is virtually unchanged since the powerhouse and the rolling dam were completed.[105]

Drainage and Other Improvements

By 1913, the distribution systems of both the Arrowrock and Deer Flat Reservoir systems (the former being lands watered out of the Main Canal and above Deer Flat, the latter being lands watered out of Deer Flat) were complete, except for some minor laterals. Farmers were generally successful in extending ditches from where the Government ended its work, and crops were growing well. Whereas 18,000 acres in the Boise Project had been under irrigation in 1908, 76,265 acres were being irrigated by 1913 (all served by water stored behind the Deer Flat Embankments). But as more lands were brought under cultivation, the water table in the Boise Valley began to rise. Poor drainage became an increasing threat to the success of newly irrigated farmlands, and thus to the success of the Reclamation Service's efforts to recoup its costs on the Boise Project.[106]

The Reclamation Service had originally assumed that farmers would take over the burden of providing drainage wherever it proved necessary, but by 1912, the urgency of the situation caused Reclamation to begin planning the construction of large scale drainage facilities in the Boise area. Water seepage had brought alkali to the surface and thus ruined 11,000 acres of fertile land. A $350,000 drainage system for the Pioneer District, to be paid for by assessing $27 per acre on the project, was proposed by the Reclamation Service in 1912. By 1914, Reclamation planned a total of $557,000 worth of drainage work, about half of which was to be paid for by the irrigation districts.[107]

The primary difficulty facing the Reclamation Service was the question of who was responsible for the drainage problem and who should pay for its solution. Should water users whose lands were not suffering damage, perhaps because they sat on higher ground, share the burden of paying to drain low-lying lands? Was overuse of water causing the problem, or was it a result of poorly designed irrigation works? The former question was answered by a court order in 1920 that demanded that all water users in a district share the cost of improvements. The second question was not easily answered, but has been discussed by historian Hugh Lovin. According to him, many Idaho water users refused to comply with state statutes requiring measurement of water deliveries. When the Government moved to enforce new 2-foot duty of water limitations and to promote a rotation system that was designed to minimize waste, farmers and developers strongly objected, citing the 1899 law that said that irrigators were the sole judges of the "amount and duty of water" necessary for their lands.[108]

Federally reclaimed lands in Idaho were not the only ones having difficulty. Carey Act projects, which had proliferated in the state in the early 1910s, were suffering variously from under- or over-allotment of water, and in 1911 the national irrigation bond market collapsed. The Department of the Interior and the Department of Agriculture were eager to assist Idaho's suffering Carey Act lands because to rescue those lands would, Lovin suggests, have established "a powerful precedent for compelling water conservation on federal tracts." An aggressive study of water needs on the Snake River plain was undertaken by the Department of Agriculture's Office of Irrigation Investigation. The results of this "scientific" investigation confirmed that a low duty of water was sufficient for the area, but this conclusion was based on the concept of farmers turning half their lands over to low-water-use grazing and forage, land uses that also happened to be low-profit. As Lovin has written, the farmers' angry challenges to government suggestions of this kind "indicated that no standard duty of water could ever be amicably agreed upon in Idaho."[109]

Even after the idea of an imposed duty of water was put aside, the Government worked to encourage irrigation rotation and other conservation measures. Many irrigators continued to see federal experts as meddling technocrats, or alternately, as inefficient and negligent. In either case, irrigators did not feel the Government had farmers' interests at heart. A particularly acrimonious situation arose on the Boise Project in 1917, the first real breach of good relations between the Payette-Boise Water Users Association and the Reclamation Service. During the summer of 1917, farmers under the Deer Flat Reservoir found that they had insufficient water to keep their

crops watered. Assembling at mass meetings, they blamed local Reclamation Service officials, calling them incompetent and demanding their immediate dismissal.[110]

Project Manager D.W. Cole responded that a series of unavoidable mishaps had caused the low water situation. Sand deposits and then ice buildup along the main canal during 1916 had been followed by a series of leaks and cave-ins during the spring of 1917, all exacerbated, according to Cole, by water users' insistence on maximum, even "extravagant" deliveries throughout. Major breaks occurred in the main canal in June and again in July. The latter break was particularly severe, requiring the assembling of a camp and 100 laborers, a difficult undertaking due to wartime labor shortages. The canal was dewatered for five days, and Cole pointed out to the agitated irrigators that "...it is unreasonable to think that a five days' shut-off of the water supply can be ruinously damaging to crops when on many projects the rotation of 'off and on' periods are frequently two weeks in length...."[111]

Despite Cole's elaborate explanation for the water shortfall, Secretary of the Interior Franklin Lane ordered an investigative team to Deer Flat. Cole informed the Reclamation's Chief of Construction F.E. Weymouth that the irrigators' protests were engineered by certain factions of the Payette-Boise Water Users Association in order to stall, or avoid, paying construction charges for the Boise Project. J.H. Lowell, an influential leader of the Water Users Association, while not confirming that thesis, agreed with Cole that the irrigators were being "unjust and unfair." While Weymouth felt that it might solve the Boise problem if Cole were replaced with a project manager who "can secure the loyal support of all his subordinates

and the water users," some Reclamation officials suggested punitive measures toward the agitators instead: "...where we find this repudiationist sentiment we would cease to spend money in furthering the system and use those moneys elsewhere until the sentiment changed."[112]

The federal investigating committee found no evidence of incompetence, and felt that the irrigators' claim that, due to the lack of Deer Flat water, "'crops representing a million dollars are dying for want of water' is grossly exaggerated." At least one investigator agreed with Cole that the water users were trying to obtain relief from the $80 per acre construction charges associated with the Boise Project.[113]

While the dispute over the 1917 water shortage was unfolding, some Canyon County farmers were seeking relief from their frustrations through political means. In 1916, a group of farmers had formed the Idaho Federation of Agriculture and then helped elect Democrats to the State Legislature for the first time since the 1890s. The Federation supported a strong state farm marketing bureau and other agrarian reforms, but when the Legislature neglected their cause, some of the farmers became involved with the Non-Partisan League. A farmer-based political organization, the League had been successful in North Dakota creating publicly-owned grain-handling facilities and procuring inexpensive credit for farmers. A representative of the League visiting Nampa in 1917 recruited many area farmers to the cause. In 1918, the League managed to place their candidates on the Democratic ticket, but for the next several years, Republicans held control of the state. The Non-Partisan League did garner

control of the county government, however, and despite accusations of "socialistic" ideas, retained a strong local pro-farmer following until 1928.[114]

Turning the Boise Project over to Water Users

The Reclamation Service did not ask for repayment of construction charges on the Boise Project until 1917. Prior to that date irrigators received water on a rental basis. When the Reclamation Service issued a public notice indicating that farmers were to begin making payments, the Payette-Boise Water Users Association rallied in protest against what they thought were excessive charges. The original estimate had been $25 per acre, and the Reclamation Service now asked $80 per acre, claiming that many aspects of the Project, including the Arrowrock Dam, had not been part of the original estimate. The Water Users' Association filed suit against the Reclamation Service, saying that the charges to irrigators should be no higher than $28 per acre.[115]

A federal district judge ruled that the water users had to pay the actual costs of construction, no matter how high, but he did rule that Reclamation had to base charges on reasonable and reviewable evidence. The judge also ruled against a Reclamation Service requirement that landowners grant Reclamation perpetual right of way to build and operate project facilities. An agreement to this effect was signed between the Payette-Boise Water Users Association and the Reclamation Service in July of 1921, but depressed farm prices prevented consistent repayment to the Reclamation Fund by the Boise irrigators.[116]

The Reclamation Service maintained a policy that irrigation districts be formed to take over the operation and maintenance of irrigation works once delivery of water commenced. Under an irrigation district, landowners would substitute a joint obligation in place of individual obligations, becoming jointly liable until the entire obligation was paid. The districts could also, according to Reclamation officials, "compel an unwilling minority to support the district plan and project, thus spreading costs over a larger and more compact area then would otherwise be the case," and thereby reducing cost per acre. The formation of an irrigation district had the added benefit of making participating farmers eligible for loans under the Federal Farm Loans Act.[117]

Some Payette-Boise Water Users Association members strenuously objected to the formation of irrigation districts, claiming that if districts were formed, water users' lands would be sold for taxes in cases of delinquency, and that project lands would lose their priority on their water filings, among other negative consequences. Two separate boards of directors of the Association were elected in 1924, one representing each faction.[118]

The "regular," non-insurgent board of directors, though it supported the formation of irrigation districts as recommended by the Reclamation Service, expressed extreme disappointment and mistrust of the agency. Directors cited the problems they had had while under the advisement of A.P. Davis, former Commissioner, and B.E. Stoutemyer, Reclamation attorney who simultaneously served as a Payette-Boise Water Users Association attorney. The release of lands under the Pioneer, Nampa-Meridian, and Riverside irrigation sectors from repayment

obligations because seepage was supplying much of their water--an action promoted by Davis and Stoutemyer according to the water users--particularly irked the Association. At this point, there was due on lands owned by Association members some $584,000 for construction, $284,000 for operation and maintenance, $80,000 for drainage works, and $18,000 for water rental fees. It was not until Secretary of Interior Herbert Work formed his "Fact Finders" commission in 1923 that relations between the water users and the Government improved.[119]

The Fact Finders critically examined the Reclamation Service, and generally determined that the engineers who had run the agency since its inception were not trained to deal with social and economic problems. For relief of the settlers on Reclamation projects, the Fact Finders recommended that the agency abandon attempts to obtain repayment within a fixed amount of time and instead collect charges on an ability-to-pay basis. For the Boise Project irrigators, this meant providing annual repayments to the Government in an amount equal to 5% of average gross crop income for the previous ten years, as determined by the office of the Secretary of the Interior. Under these terms, all but the most radical Boise Project water users agreed to organize into districts and take over operation and maintenance of the irrigation works. The Government ceased to deal with individuals once districts were formed in an irrigated area, and the Payette-Boise Water Users Association eventually collapsed into receivership with debts of $54,000.[120]

The Nampa and Meridian Irrigation District had been in a contractual relationship with Reclamation since 1909, when it agreed to allow the Government to use a portion of the Ridenbaugh Canal to serve project lands in the district. On March 2, 1926,

the district became the first of several districts on the Boise Project to sign a contract with the Federal Government stipulating that the Project would be operated by a central Board of Control. The Boise-Kuna, Big Bend (Oregon), and Wilder Irrigation Districts soon followed, and the transfer of operation and maintenance responsibilities from Government to the districts was completed by April 27, 1926. The Board of Control was formed of representatives from each district, the number of representatives determined by the acreage in each district. The New York and Black Canyon Irrigation Districts joined the organization by the end of the year. The plan of having several districts with a shared Board of Control, rather than a single district including all project lands, insured proper representation of the different kinds of lands involved--high and low, sandy and loamy, close to water sources and distant. The formation of multiple districts under a project was also preferred by Reclamation administrators because, according to attorney Stoutemyer, it "prevented control by a few determined men for their own purposes."[121]

The Nampa and Meridian Irrigation District was organized in 1904 to purchase and operate the Ridenbaugh Canal. The district encompasses lands in a swath ranging from five to seven miles wide and extending from the Boise River just downstream of Boise to Lake Lowell. At the time of organization, the district contained 67,000 acres of irrigable land, but a smaller amount was developed for farming and a still smaller amount was actually receiving water. Approximately 16,000 acres in the district are situated above the Ridenbaugh Canal and so receive water through the New York Canal. Of the remaining lands in the district,

about 24,000 have a full water right to water stored by the Boise Project. These and the remaining acres in the district obtain water through the Ridenbaugh Canal.[122]

The Boise-Kuna Irrigation District and the Wilder Irrigation District were not organized until 1926. Located south of a line running roughly due east of the upper end of Lake Lowell, the Boise-Kuna District is comprised of lands owned by members of the former Payette-Boise Water Users Association. The district includes about 45,000 acres of irrigable land. The Wilder District encompasses about 50,000 acres of irrigable lands northwest of Lake Lowell and between the Snake River and the Boise River to the Oregon border. Like the Nampa and Meridian District, about half of the irrigated land in the Boise-Kuna District was in hay and forage in 1950, about one quarter of the land was in cereal grains, and the rest was in vegetables, alfalfa, sugar beets, and other mixed crops. The Wilder District had about the same percentage of land in grains, but a smaller percentage in hay and a larger percentage in fruits and vegetables.[123]

The Big Bend Irrigation District consists of all the lands on the Boise Project which are east of a bend in the Snake River and lie in Oregon. The district was organized in 1917 to contract with the Federal Government for the drainage of lands being irrigated by the Riverside Canal and for a water-right to supply the canal with water stored by the Boise Project. The Riverside Canal Company, Limited, had purchased the partially-built Riverside Canal, completed its construction, and began supplying water to farms in 1894. The canal diverts water from the Boise River near Caldwell. About 4,000 acres receive water through the Riverside Canal. In 1920, an additional 1,600 acres,

located within the bend in the Snake River and which were irrigated by canals and laterals built by the Reclamation Service, were incorporated into the Big Bend District. In addition to hay and grains, much of the land in the Big Bend District in 1950 was planted in seed crops.[124]

The early history of the New York Canal Company has been described above. The Bureau of Reclamation supplied water to lands served by water rights of the old New York Canal under a contract to the New York Canal Company until 1926. In a four-party contract signed that year, the New York Canal Company agreed to transfer all of its interests and obligations to the newly-formed New York Irrigation District and the Boise-Kuna Irrigation District (about 3,000 acres of the 20,000 served by the New York Canal Company fell within the boundaries of the latter district). The Reclamation Service agreed to supply water, through the two irrigation districts, to all the lands formerly served by the company.[125]

Repayment of Boise Project Costs

Repayment of construction charges on the Boise Project fluctuated with farming conditions. A severe depression of crop prices followed the end of World War I. Idaho corn that sold for $1.65 a bushel in 1919 sold for 50 cents in 1921. Population growth in the valley also slowed. Between 1910 and 1920, Nampa grew by 81%, but in the following decade, the town grew by less than 8%. Some farmers tried switching from hay and alfalfa to more lucrative crops like barley, Indian corn, and beans, but conditions remained poor. With the onset of the Great Depression in the early 1930s, the Federal Government instituted a moratorium on repayments, holding collections down to less than

$20,000 a year on the Boise Project, as opposed to collections ranging between $120,000 and $342,000 per year, as had been received between 1918 and 1932. Operation and maintenance collections also diminished in these years.[126]

Conditions improved slightly in 1935. The Amalgamated Sugar Company began promoting the raising of sugar beets, and in 1937 erected a $2-million processing plant at Nampa. Seasonal laborers from Mexico were hired to assist with the increasing sugar-beet and truck-crop cultivation. Canning factories, livestock auction yards, and creameries proliferated. As conditions improved, the irrigation districts in the Boise Project contracted with the Federal Government to build another dam and reservoir, Anderson Ranch Dam on the South Fork of the Boise River, authorized in 1940. In the early 1940s, agricultural prices jumped by almost 40%, assisted in Idaho by the construction of a major highway between the southern part of the state and California. World War II also helped Idaho farmers, as it did most sectors of the American economy. By 1947, the irrigation districts in the Arrowrock Division had paid $6,238,871, or about 48%, of their obligations to the Reclamation Fund. About $13 million was still owed at this point.[127]

Because Boise Project water users repaid their debt to the Reclamation Fund on the basis of a 10-year "moving average," ending with the previous year, prosperous years could cause high payments to be required even after crop prices fell again. This is what happened following World War II, and in 1950, the irrigation districts on the project requested an investigation of the possibility of changing their repayment terms. Members of the Boise-Kuna, Nampa & Meridian, New York, and Wilder Irrigation Districts encountered particularly difficult debts because of the

construction of the Anderson Ranch Dam and Reservoir for approximately $5 million in 1941. According to the report issued by Reclamation's investigators, water supply for the Arrowrock Division had been "seriously short" during four years and "inadequate in varying degrees" in twelve additional years since 1912, and labor costs and replacement costs for aging facilities were steadily adding to the farmers burdens. Considering these general conditions, and the individual conditions on the various irrigation district lands, Reclamation recommended various degrees of relief for the different districts. These depended in part on how much debt each district had left, and are detailed in the "Economic Report and Repayment Plan" of 1951.[128]

As of 1957, about $12 million dollars was still owed by irrigators on the Boise Project; it was estimated that another 22 years would be needed to pay off this debt. But as noted by Neil Carlton, a historian of the Boise Project, there have been indirect profits to the Government on the Boise Project lands, especially in income taxes. With the completion of the Boise Project, more lands came under irrigation, contributing to the growth in population of the Boise area from 54,411 in 1910 to 160,249 in 1960. Property values increased over the decades to reach an average of $500 per irrigated acre in 1964. Total value of all crops in that year was determined by a Bureau of Reclamation Census to be about $40 million, with sugar beets and cherries being the most lucrative crops, but forage taking up more than half of the 181,648 acres on the Boise Project. Short growing seasons and the distance to large urban markets made it difficult for Boise Valley farmers to compete in "garden" vegetable production, but livestock, poultry, and dairy businesses thrived in the region. As Carlton has summarized, except for the Depression years, "progress in every criteria has

been substantial and sustained" on Boise Project lands. Certainly this is indisputable when one compares the valley's original sagebrush-covered lands to its contemporary irrigated farms.[129]

PROPOSED ALTERATIONS

Planned Alterations to the Deer Flat Embankments

Erosion of the upstream faces of both Deer Flat Embankments has continued since the repairs of the 1930s. Damage to the Lower Embankment has been especially severe. In 1990, the Bureau of Reclamation will reconstruct the northern-most 4,500 linear feet of the upstream face of the Lower Embankment. The damaged upstream face and upstream shell will be excavated to stable material, estimated to occur about 20 feet upstream of the centerline of the structure. This procedure will necessitate removal of the CCC-built parapet wall. Material removed from the face will be mixed with new material and reapplied to form a new shell with a 2:1 slope (less steep than the CCC-built 1-1/2:1 slope). A layer of soil cement will be applied over the fill to armor the embankment. Reclamation will replace the removed parapet with a pre-formed concrete wall (Jersey barrier). No alterations will be made to the remainder of the Lower Embankment with its intact CCC parapet and riprap or to the outlet towers and works.

Reclamation also plans to alter the downstream toe of the Upper and Lower Embankments to control internal erosion and to reduce excessive uplift pressures. At each embankment, a trench will be dug parallel to and just downstream of the toe to a depth just below the layer of earth upon which the embankments are built. Drainage pipes and sand and gravel backfill will be placed in the trenches to carry seepage away from the toe. Counterbalancing fill will then be placed over the trenches and toes of both structures to a depth of 8 feet. A protective cobble cover will be placed over the fill.[130]

Reclamation will make no other alterations to the Upper Embankment. The CCC-built parapet and riprap are in good condition and will remain undisturbed. Neither will there be any alteration to the outlet works. There will be no alterations to the East Dike and Forest Embankment.

The new upstream face and parapet on the Lower Embankment will alter its appearance from the course texture of the CCC work to the relatively smooth character of soil cement and the Jersey barriers. The northern-most 4500 feet will lose all of its visual integrity, while the southern-most 2500 feet will retain its visual integrity. The work along the downstream toes of the Upper and Lower Embankments will change the profile of the downstream faces slightly, but the change will have a negligible effect on the visual integrity of the embankments.

Project Statement

This HAER documentation of the Deer Flat Embankments was prepared by Renewable Technologies, Inc. (RTI) of Butte, Montana, under contract to the Pacific Northwest Region of the Bureau of Reclamation as part of the mitigation of the adverse effects caused by the structural improvements to the Upper and Lower Embankments. The large-format current-view photographs which are a part of this documentation were taken by Clay Fraser of Fraserdesign, Loveland, Colorado, under a separate contract. The rest of this documentation package was prepared by RTI. Fredric L. Quivik, architectural historian, conducted the field recording in April 1990 and wrote the physical descriptions of the embankments and other features of the Boise Project. He was assisted by Amy Slaton, historian, in researching and writing the historical portions of the narrative during the summer of 1990.

Ms. Slaton prepared the sections of the narrative pertaining to settlement and repayment. She and Mr. Quivik jointly wrote the other historical sections. Ms. Slaton and Mr. Quivik selected the historic photographs and engineering drawings which form a part of this documentation. Lynne MacDonald, Reclamation's Technical Representative for the contract, provided significant editorial recommendations on the narrative.

ENDNOTES

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31. Ibid., 4-7, 54, 88, and drawings appended to the report. The drawings appended to this report present less detail than those which were developed to accompany Specifications 68, upon which the actual construction was based. However, they are very similar, and they indicate that the basic plans for the Diversion Dam, Deer Flat Embankments, etc. had been worked out by February 1905.

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39. Hogue, "History of the Payette-Boise Project," 42-43.

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42. Hogue, "History of the Payette-Boise Project," 47-49.

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47. Ibid., 57-67; F.W. Hanna, "Concrete Lining of the Main Canal on the Boise Irrigation Project," Engineering Record 66 (21 December 1912): 680.

48. Hogue, "History of the Payette-Boise Project," 40, 67-71.

49. James Leffel, The Construction of Mill Dams: Comprising Also the Building of Race and Reservoir Embankments and Head Gates, the Measurement of Streams, Gauging of Water Supply, &C (Springfield, OH: James Leffel & Co., 1874), 276-277.

50. The storage structures on the Umatilla and the Belle Fourche projects are actually dams. Cold Springs Dam was built on Cold Springs Canyon to store water supplied by a diversion canal from the Umatilla River. It is 100 feet high. Orman Dam, the main storage structure on the Belle Fourche Project, is a 115-foot high dam on Owl Creek. It serves, however, as an off-stream reservoir because its major source of supply is by means of a

diversion canal from the Belle Fourche River. The first earthfill dam built by the Reclamation Service to impound water in the river on which it was built was the 1909 Clear Lake Dam on the Klamath Project in Oregon and California. It was only 39 feet high. The first Reclamation dam over 100 feet high to be built in a river was the 1911 Lahontan Dam on the Newlands Project in Nevada. U.S. Bureau of Reclamation, Reclamation Project Data (Washington, DC: Government Printing Office, 1948), 18, 169, 293; A.P. Davis, "Comparative Costs of Earthwork," The Engineering Record 57 (16 May 1908): 628-629.

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103. Ensign, "A Hydroelectric Plant for Construction Works," 209-211.

104. Charles H. Paul, "Rolling Dam of the Boise Project," Engineering Record 68 (2 August 1913): 125; A.G. Hillberg, "Design of Rolling Dams," Engineering Record 68 (13 December 1913): 657.

105. The Bureau of Reclamation ceased generating electricity at the Diversion Dam in 1972, although it maintains the equipment in operating condition. At the time it ceased operating, the Diversion Dam generated only during the irrigation season (about six months between April and October), during which enough water was being discharged down the Boise River to make generation economically viable. "Operations Log Books" kept at the Diversion Dam Powerhouse and personal interview with operator Pat Smith, 18 April 1990.

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